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Index to Advertisers and Classified Index Following Reading Matter.

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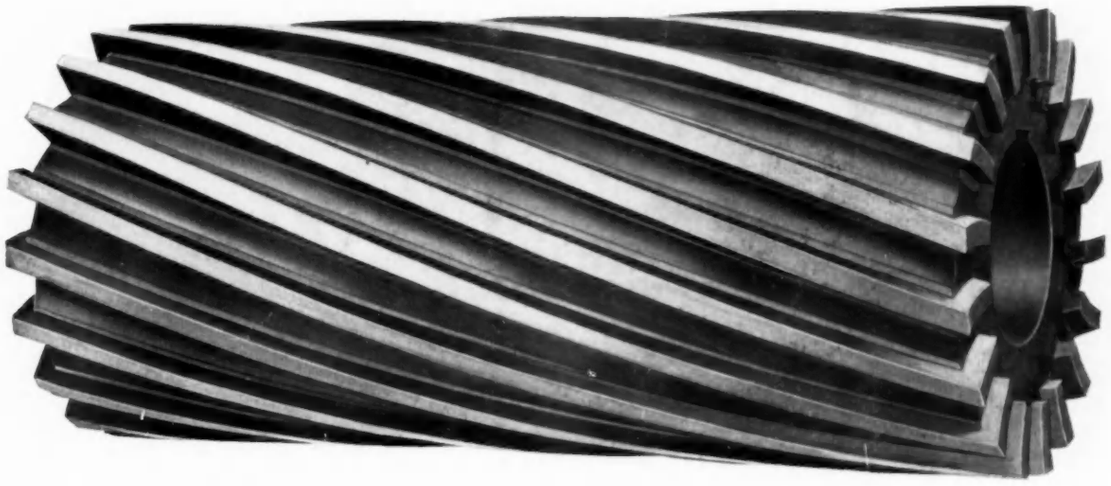

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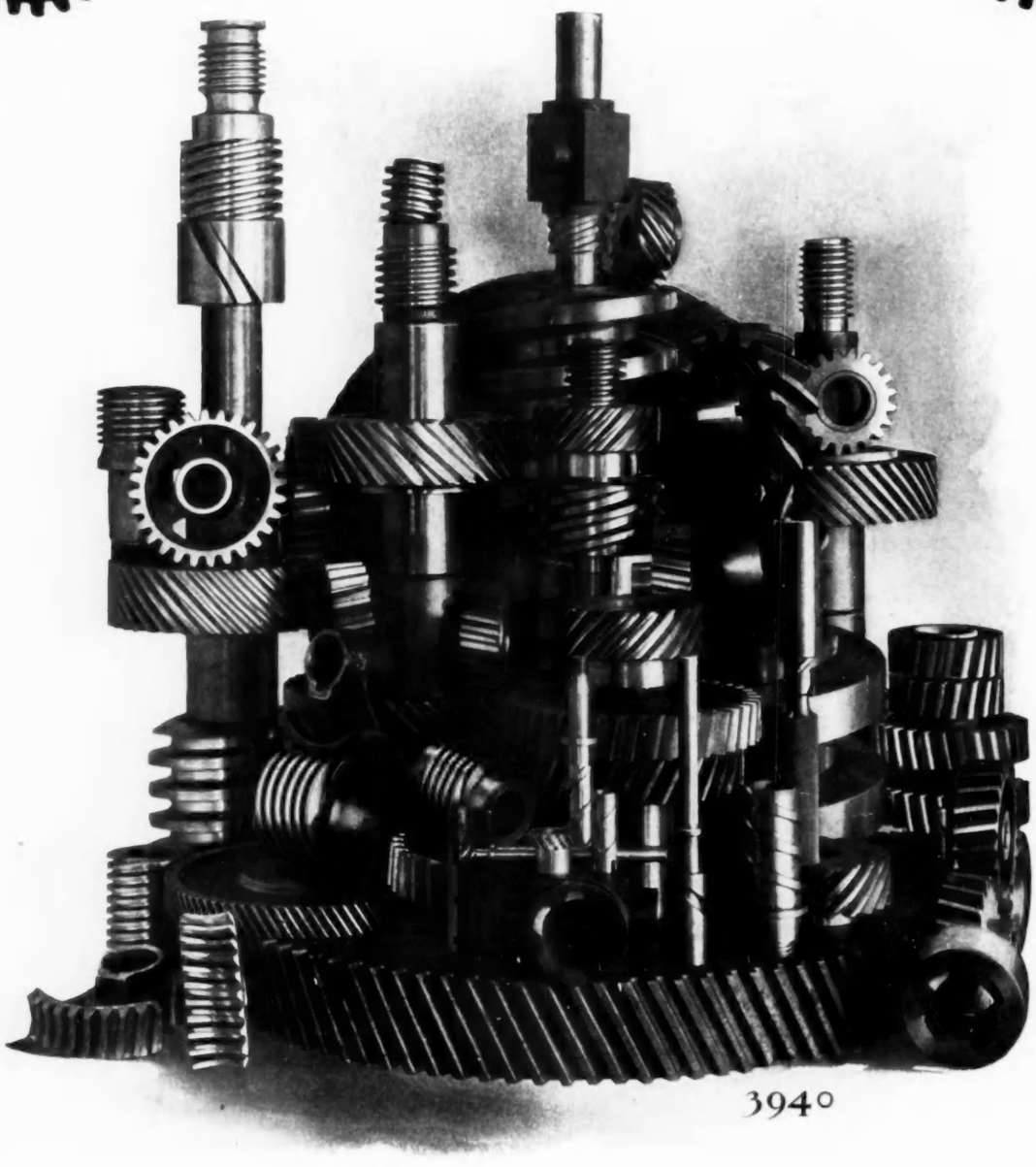

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A Jig Boring Machine of English Design

A Vertical Spindle Tool Using End Measuring Rods and Micrometer Adjusting Devices for Accurately Locating the Table and Work

BY I. W. CHUBB

The firm of Alfred Herbert, Ltd., Coventry, England, recently constructed a set of three jig-boring machines, interest in which is not confined to the country of origin. One machine is in use in the tool room of the firm's branch works at Edgwick. The others were built for important British arsenals for the purpose of producing and reproducing the various jigs used in the manufacture of gun mountings. The tool illustrated in Fig. 1 is essentially a very heavy precision vertical drilling and boring machine, having a large compound table for carrying and adjusting the work in exact position under the spindle. It weighs about 16,000 pounds and occupies a floor space of about 12 feet by 15 feet 6 inches. The chief dimensions are given at the end of this article.

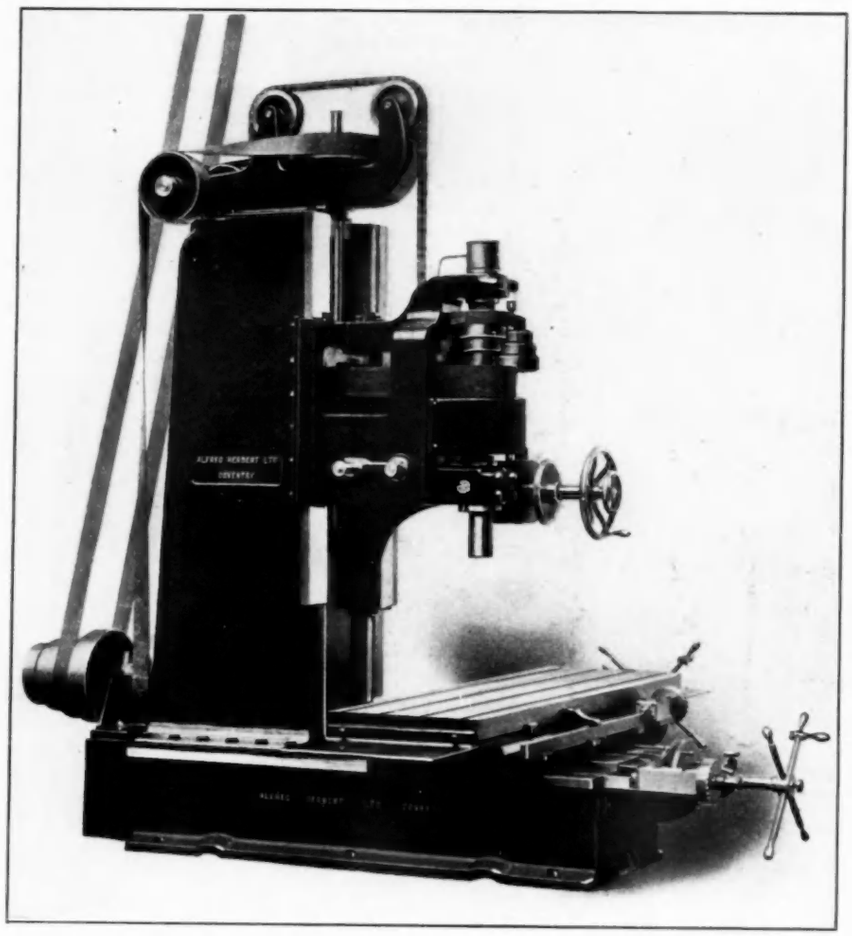


FIG. 1. JIG-BORING MACHINE

Column and Spindle Head

The spindle head moves bodily when feeding and the spindle does not feed down through the head. The boring tool is, therefore, at a constant distance from the bearings, the result being that the holes bored are parallel and square with the table just in the same degree as the column is square with the table. The final boring of the holes in jigs is done by a single-point tool having a fine adjustment for regulating the size and assuring accurate work. It will be seen that the back gearing gives the machine enough power to bore large holes quite efficiently and at the same time it is used for such small holes as ¼ inch. The column of the machine is of box section and has a square slide for the spindle head. This is guided by two surfaces close together at the right-hand side, forming a slide of considerable length in proportion to width. Taper gibs extend the full length of the slide and a clamping lever is provided at the right-hand side. The base and column form, in fact, a large precision square, the spindle head moving vertically on the column and the table horizontally on the base. The spindle is carried in two conical bearings. These are driven tight into the head and are independently adjustable without changing their alinement, while the adjustment is not affected by expansion due to increase of temperature. Both bearings are lubricated by a large siphon oiler at the top of the head. The thrust is taken on friction washers ground and lapped and having ample oil grooves. The spindle nose is bored No. 5 Morse taper and has an extra cotter hole for holding up the arbors.

The spindle drive, as in Figs. 1 and 2, is from a two-speed countershaft through a 4-step cone pulley and idlers to a vertical shaft running down the front of the column. This shaft is splined and drives a pulley which moves up and down with the spindle head in a recess in the column. This pulley drives another which runs on the spindle, giving it 16 speeds, ranging from 11 to 545 turns a minute, either by back gears for heavy roughing cuts, or direct by belt for finishing cuts. An adjustable idler pulley regulates the tension of the horizontal belt connecting the pulleys in the spindle head. The smoothness of the direct-belt drive was found to be very beneficial to the finish of the holes bored.

For the automatic feed a 4-step cone on the spindle drives a similar cone on a parallel shaft. This has at its lower end a worm which drives a worm-gear running loose on a horizontal shaft. With a hand-wheel on the outer end of this shaft the loose worm-gear can be locked by a fine V-toothed clutch when the automatic feed is to be engaged. The horizontal shaft carries at its inner end a worm which drives another worm-gear running loose on a short shaft. This has at its inner end a rack pinion and at its outer end a pilot wheel is keyed to it which can be clutched to the loose worm-gear when the automatic feed is engaged. The pinion meshes with a rack secured to the front face of the column, the top being just visible in Fig. 2. Thus when both clutches are engaged a fine automatic feed is obtained, varied from 71 to 323 turns to the inch by the four steps of the cone pulleys. The clutch at the front being disengaged, a fine hand adjustment is obtained from the hand-wheel, which has an adjustable index disk for accurate setting for depth, and when the clutch on the

pilot wheel is disengaged from its worm-gear, a quick hand adjustment is given.

The spindle head is balanced by weights located inside the column and attached by a chain. The weights, being slightly the heavier, have a tendency to lift the head in the same direction as the thrust of the feed, taking up all lost motion before the feed comes on. The top of the base forms a seat for the column and also a slide for the transverse movement of the saddle. The latter is guided by a narrow raised part central with the traversing screw, the adjustment being by a taper gib. It is held down by flat gibs at the outer edges.

Adjustment of Slides

The table slides in a long bearing in the saddle, the adjustment being by taper gibs. It is made specially deep to avoid deflection and has four ¾-inch T-slots in its surface. Both table and saddle are adjusted by screws 2 inches in diameter, 5 threads to the inch, working in long phosphor-bronze nuts with adjustment for wear. The ends of the screws carry large adjustable index disks, reading to thousandths of an inch. Intended for moving the tables, but not for measuring the movement, the screws are not necessarily specially accurate, the index disks on them being used only for comparatively rough settings. Arrangement for clamping the tables both longitudinally and transversely is, of course, provided and both screws are covered throughout their length to prevent dirt getting on them.

Steel scales and adjustable pointers, as in Fig. 3, for the longitudinal and transverse movements permit approximate settings and obviate the necessity of counting the revolutions of the screws when making long adjustments.

To secure accurate definite positioning, the lubrication of the two main slides of the machine must be efficient. Oil wells are consequently provided in the saddle, for lubricating the top slide by means of rollers and the bottom slide by siphon wicks. The wells are replenished by means of small feeding cups at the front and back of the saddle.

End-measuring Rods vs. Screws

End-measuring rods are used for setting instead of precision screws, for very good reasons. First, the cost of precision screws was prohibitive; second, the best precision screw cannot be made so accurate as an end-measuring rod; third, the screw would wear more or less rapidly owing to the weights to be moved, and fourth, the torsion of a screw would affect its accuracy. On the other hand the rods are low in cost, can easily be made accurate to 0.0001 inch, do not wear appreciably and can easily be checked for length from time to time.

The minimum number of rods considered necessary was 25. One rod is 36 inches long and the others measure from 1 inch up to 24 inches by 1-inch steps, thus enabling any dimension up to 5 feet to be obtained with not more than two rods. They are ¾ inch in diameter with spherical ends. The subdivisions of the inch are obtained by means of the micrometers described later, although in the firm's practice accurate thickness pieces are used for all subdivisions except the last few thousandths. Fig. 3 shows the longitudinal micrometer with an end-measuring rod in position and the gravity piece ready to drop, while Fig. 4 illustrates the transverse micrometer. These micrometers are similar. They are attached to stiff brackets on the saddle and bed of the machine respectively.

Micrometers

Each consists of a rectangular base of cast iron carrying an accurate bronze nut. The nut is split longitudinally, the lower part surrounding the screw with a contact of about 240 degrees, the upper part having a contact of about 120 degrees. The lower part is prevented from rotating by a key, and is pressed by spring plungers against the back of a recess in the nut holder, which thus takes the thrust. This part forms the actual measuring nut. The upper part is constantly pressed back against the threads of the screw by spring plungers so as to take out all backlash. The lengths of the nut and of the screw are equal. The micrometer screw has ten threads to the inch with a graduated dial at the back end. The threads are of buttress form. The dial is non-adjustable and forms in fact the hand-wheel by which the micrometer screw is adjusted. The dial, in the form of a hollow cylinder with a beveled edge for the graduation, is divided into 200 parts, each of which corresponds to an end-movement of 0.0005 inch, but as 0.001 inch is represented by about 3/16 inch on the dial much finer graduations can be had if desired. A cylinder attached to the body of the micrometer fits inside the dial and has marked along it a line indicating zero, with cross lines indicating every tenth longitudinal movement of the screw in a way similar to the graduations of an ordinary micrometer.

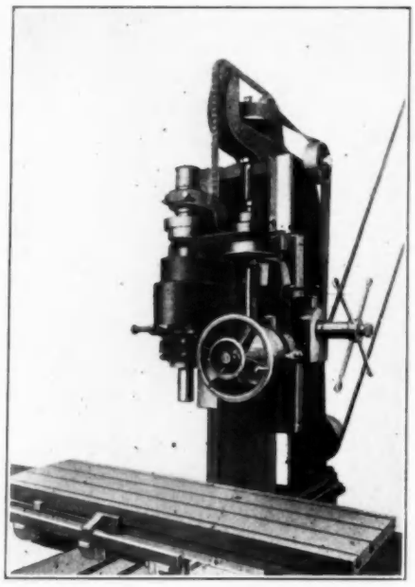


FIG. 2. HEAD OF JIG-BORING MACHINE

The micrometer screw has behind the dial a cup-shaped piece of steel, hardened, ground and lapped, driven on tightly and forming part of the gravity device. The screw is hollow and carries within it a plunger which can move endwise relatively to the screw, and is prevented from turning in relation to it by a spline and key. This plunger projects beyond the front of the screw and has a spherical end which is hardened, ground and lapped, and forms the part which comes in contact with the end-measuring rods. The plunger is held forward by a spring. At the back end, keyed up on it is a hardened and lapped steel disk which forms, in conjunction with the other disk, the gravity device. A light spring holds the disks apart and the gravity piece itself is carried between them. The end of the internal rod is threaded and has an adjusting nut on it with a locking device.

Gravity Device

This construction allows the internal rod to be adjusted by the nurled nut for about ½ inch independent of the adjustment of the micrometer screw by the dial. When pressure comes on the end of the internal rod, it is pushed back, and the disk on it moves with it, thus releasing the gravity piece, which drops. The gravity piece shown in Fig. 4 is a hardened and lapped cylinder, having a nurled handle and a flange which enters recesses in the faces of the disks so as to prevent the piece from falling out altogether when released. The gripping faces of the disks have their edges formed so as to hold the gravity piece by three points, two on one disk and one midway between them on the other disk.

The rods are guaranteed accurate to 0.0001 inch. In use they are carried in a shallow V-groove, in a long bar which is mounted on edge and attached to the saddle by brackets in the case of the longitudinal motion, and in a V-groove in the base of the machine in the case of the transverse motion. The continuous contact of the rod along the groove tends to maintain equality of temperature between the machine and the measuring rod. This is of some importance. The end of the longitudinal measuring rod farther from the micrometer rests against a stop which is adjustable in various positions and can be locked at any point.

Using the End-measuring Rod

To move the table from any position to another a given distance away, set the dial of the micrometer at zero and move the adjustable stop on the table against

the end of the internal rod on the micrometer and lock it there. Then adjust the internal rod in the micrometer by the nurled nut until the gravity piece just drops. Suppose the table is to be moved 5.375 inches. First set the index disk on the table screw to zero. Then move the table by the table screw rather more than 6 inches, say 6½ inches, insert a 5-inch end-measuring rod between the micrometer and the table stop, adjust the micrometer screw outward 0.375 inch and wind the table back by the main screw until the gravity piece drops. The table will then be correctly located. The index disk on the table screw can be used to indicate when the required position of the table is nearly reached so that the final movements may be made slowly. Subsequent measurements can be taken, the index disk and the micrometer being set to zero for each measurement. This applies more particularly to the longitudinal movements.

The transverse movement is the same in the main, but the stop on the saddle is not adjustable and any suitable end-measuring rod is inserted to fill the space between the stop and the micrometer before any measurements are made. In the above example a 5-inch end-measuring rod was used to give a dimension in excess of 5 inches. It would, of course, have been equally possible to use a 6-inch end-measuring rod, adjusting the micrometer back an amount equal to the difference between 5.375 and 6 inches.

In practice it is customary to take the dimensions from a base line which is represented by a perfectly square and carefully surfaced angle plate fixed at right angles to the table as shown in Fig. 3. When this is done the position of the first hole is obtained by placing a true plug of known diameter in the spindle and bringing it up so as just to hold a feeler of known thickness against the angle plate. The starting position of the spindle with regard to the angle plate is thus easily and accurately obtained.

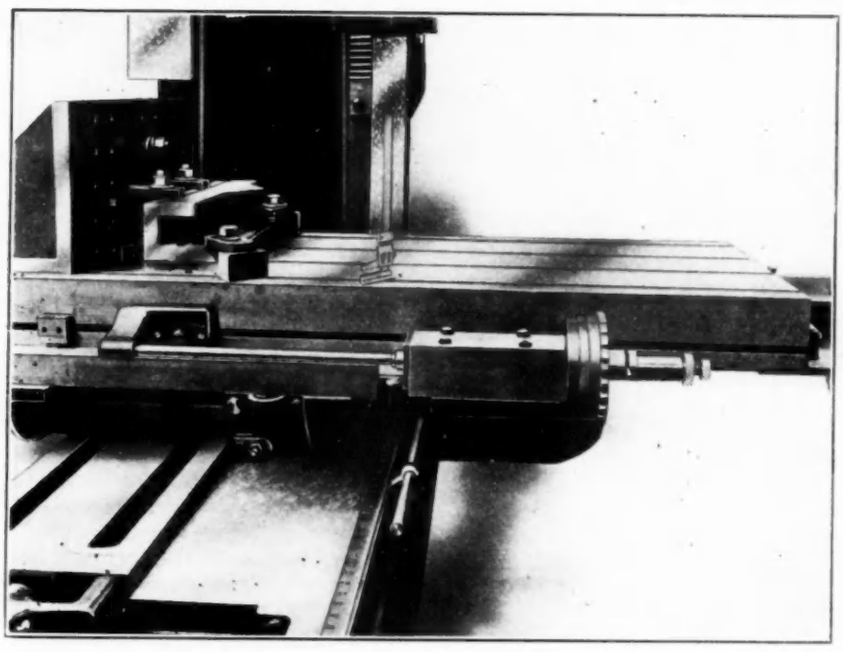


FIG. 3. MEASURING ROD AND MICROMETER FOR SETTING TABLE

Fine Adjustment

In order to move the tables through small distances with smoothness and accuracy, a fine adjustment is provided to each main screw as shown in Fig. 4. It consists of a lever with an adjusting screw at the end which bears on a fixed abutment. The lever is normally free, but can be clamped to the screw when required. When it is thus clamped, very fine angular movements of the screw can be obtained by rotating the adjustment screw.

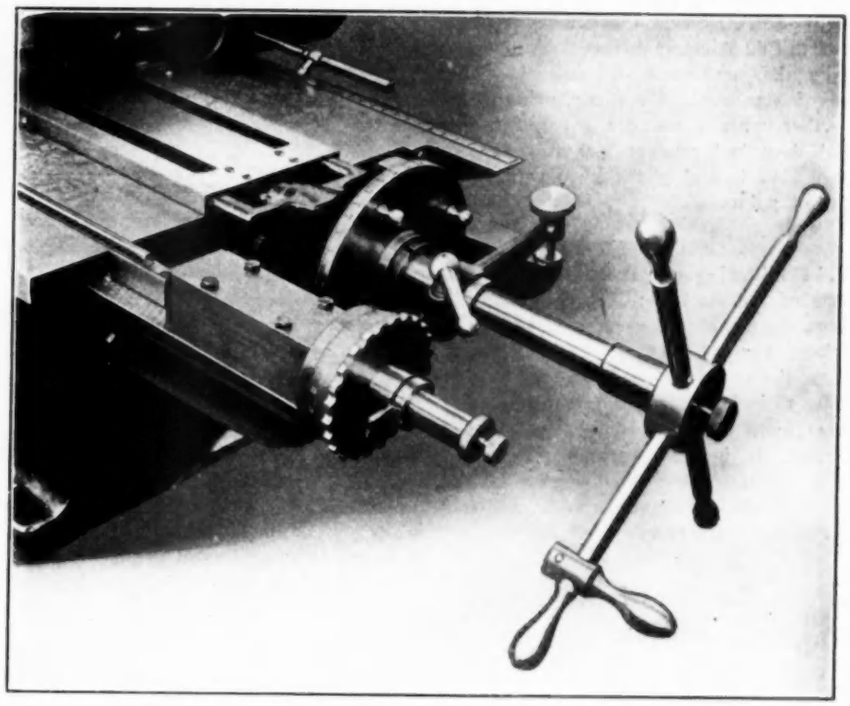


FIG. 4. MEASURING ROD AND MICROMETER FOR SETTING TABLE

To Insure Accuracy and Smooth Working

In connection with precision machinery the firm recognizes the difficulties, first in obtaining sufficient accuracy when the machine is new, and second in maintaining that accuracy. Obviously in the case of a large machine such as this the difficulties are much greater than with small bench machinery. Changes of form in the castings are almost certain to occur and will be greater if the foundation of the machine is not of the best. In building these machines the main castings were allowed to mature for twelve months after planing and before the final adjustments were made. It was also found necessary to erect the machines on foundations as solid as those on which they would rest in work.

The precision level played an important part in the erection, and the square which was used to set the column true with the base consisted of a long cylinder, ground up all over and with one end recessed in the center so as to rest firmly on the base. By rotating the cylinder on its end, its accuracy as a square could easily be checked. Then, so that the various slides might work smoothly and with uniform resistance in different parts of their travel, after they were surfaced and carefully bedded together they were reciprocated rapidly by power, with the gibs closely adjusted and with ample lubrication. The various slides were in fact

coupled in turn to a planing-machine table. The effect was to produce in a short time a degree of smoothness of working, which it would have taken years to attain by the effect of wear during the ordinary operation of the machine.

The firm realizes that such machines may require occasional adjustment, owing not only to the wear of the slides, but also to changes in the form of the castings, and the user who wishes to obtain really accurate work will naturally check over the machine from time to time and make the necessary adjustments. The use of standardized end-measuring rods together with a cylinder square of the kind described renders it quite easy to keep a periodical check on all the important points.

Principal Dimensions

The following are the leading dimensions of the machine: Longitudinal traverse, 60 inches; transverse traverse, 30 inches; vertical feed, 33 inches; maximum distance from end of spindle to table, 39 inches; minimum, 6 inches; distance from center of spindle to face of column, 24 inches; working surface of table, 85x24 inches; the diameter of the spindle body is 2½ inches, and the diameter of the main bearing, 3½ inches.

Piece Rate System for Special Work

By A. B. Smith

The premium plan and direct piecework schemes are now being used extensively by manufacturers endeavoring to decrease the cost of work that is made in quantities. Under correct methods it should prove economical to adopt piecework methods for jobbing as well as on manufacturing work.

In the building of drilling jigs, milling fixtures and other work of this character it may seem impracticable at first to give a toolmaker a fixed price for making them and it probably would be inadvisable to give to one man complete jigs to build for stated sums.

Department Divisions

Under my charge are about one hundred men and over these men are several gang foremen, each foreman having under him from 8 to 20 men. The work is subdivided so that all planing is controlled by foreman A, all lathe work by foreman B, all plain drilling and tapping by foreman C, all assembling of special work and boring of holes in jigs, etc., by foreman D. In addition to these foremen there are leaders on fitting and scraping, and on ordinary machine erecting, etc., but it is seldom on jig work that the latter are employed.

From the foregoing statement it will be understood that the department force is divided into groups of men who should be especially efficient in their respective lines.

In "piecing out" a drilling jig several written contracts to the men are made, generally one each for the planing, turning, drilling and tapping, and boring and assembling, making four in all for each job.

Time Estimates

At first one's judgment as to the proper time to allow for the various operations is liable to be at variance with what actually can be accomplished, but where special work is being done frequently and proper records are taken it becomes quite as easy to estimate closely in detail the probable time on jobbing work as in manufacturing work done in large lots.

If one starts out to estimate directly the total time of making a complete jig it is seldom that the records of total time taken to produce other jigs will be of much value, and contracts made out unless uniformly fair will hurt the contract system; so that it seems best to divide the work into the various operations and to "piece out" accordingly.

Detail operations on a new jig are similar to detail operations on many other jigs, hence records of detail operations tend to insure the accuracy of an estimate on new work. Furthermore, if work be continually divided into classes and given out to specialists, one soon becomes expert through experience and satisfactory results due to closeness of the estimate are insured.

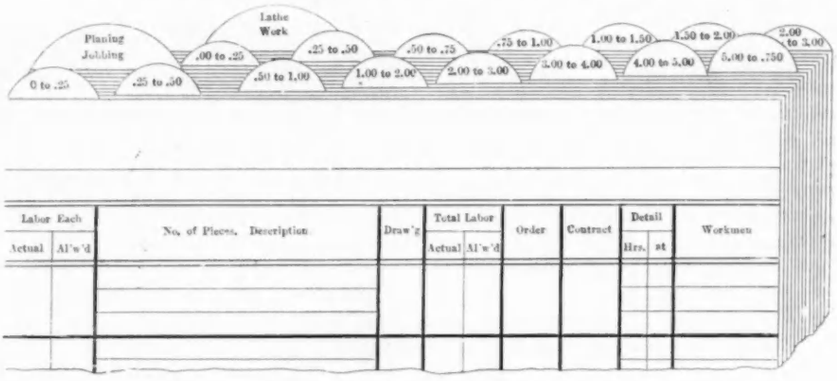


FIG. 2. FILING RECORD CARDS

Planing Jobbing
Value 1.00 to 2.00

Labor Each Actual	Labor Each Al'w'd	No. of Pieces. Description.	Draw'g	Total Labor Actual	Total Labor Al'w'd	Order	Contract	Detail Hrs.	Detail at	Workmen
1.60	1.50	1 Jig Body 4x6x3 2 Straps (.002 to .004 limit) 1 Plate 2x2x½	C 1705	1.60	1.50	79114	1403	4 2	25 30	Watson Deane
1.05	1.25	2 Jig Body 4x5x2 .001 to .002 limit	J 1401	2.10	2.50	82111	1472	3 3	35 35	Miller Emms
1.20	1.50	1 Jig Body 8x5x3 1 Strap .002.5 limit	C 1762	1.20	1.50	82141	1536	4	30	Lilly
1.20	1.40	1 Jig Body 4x6x3 1 Swinging Plate .0015 limit	C 111	1.20	1.40	83901	1609	2 2	30 30	Deane Small

FIG. 1. RECORD CARD FOR SPECIAL WORK

Filing Records

The advisability of having the records of the cost of work so filed as to give one a number of comparisons simultaneously is obvious and a description of such a method may prove of interest. Fig. 1 represents a card upon which the price allowed and afterward the actual cost of work and also a short description are written. These cards permit of several entries but all entries must be of a class and within a cost limit noted in the heading on the card. The cards in use are filed in accordance with the headline memorandum; i.e., all costs of planing are filed or grouped in front of a division card marked "Planing"; cost cards covering lathe work are filed in front of a division card marked "Lathe Work" and so on. The several groups are furthermore subdivided by rate or value cards as in Fig. 2. The card in Fig. 1 would be filed under "Planing" and in front of the $1 to $2 rate card where also would be filed all other cost cards for work covering the same class of work produced for a figure

within that on the rate card, namely $1 to $2.

Checking by Operations

In "piecing out" work one should first assume an approximate temporary figure for the operation and then check by cost cards of previous work on a similar operation, looking for this information on cards in front of a rate card in the correct class or division. If it is found by comparison with these cards that more elaborate work has been performed for the approximate figure one naturally looks through cards filed within a lower rated division. If, on the other hand, the approximate figure seems to be low, higher rate cards are then referred to.

After the cost cards have been in use a sufficient time to accumulate records it will be found possible to arrive at a figure for new work that will be very close to the actual cost. It is, of course, obvious that the accuracy required of a jig has much to do in determining the value of the work to be done and the records should be such as to assist in this respect.

Application of the System

The method outlined has been in use about four years in one of the largest shops in the New England States and is giving excellent satisfaction; it is estimated that costs of jigs are from 35 per cent. to 50 per cent. lower than when built by the day.

All work of the character described is to dimensioned drawings and if, as is sometimes the case, alterations are made to the design, proper changes in the men's contracts are made.

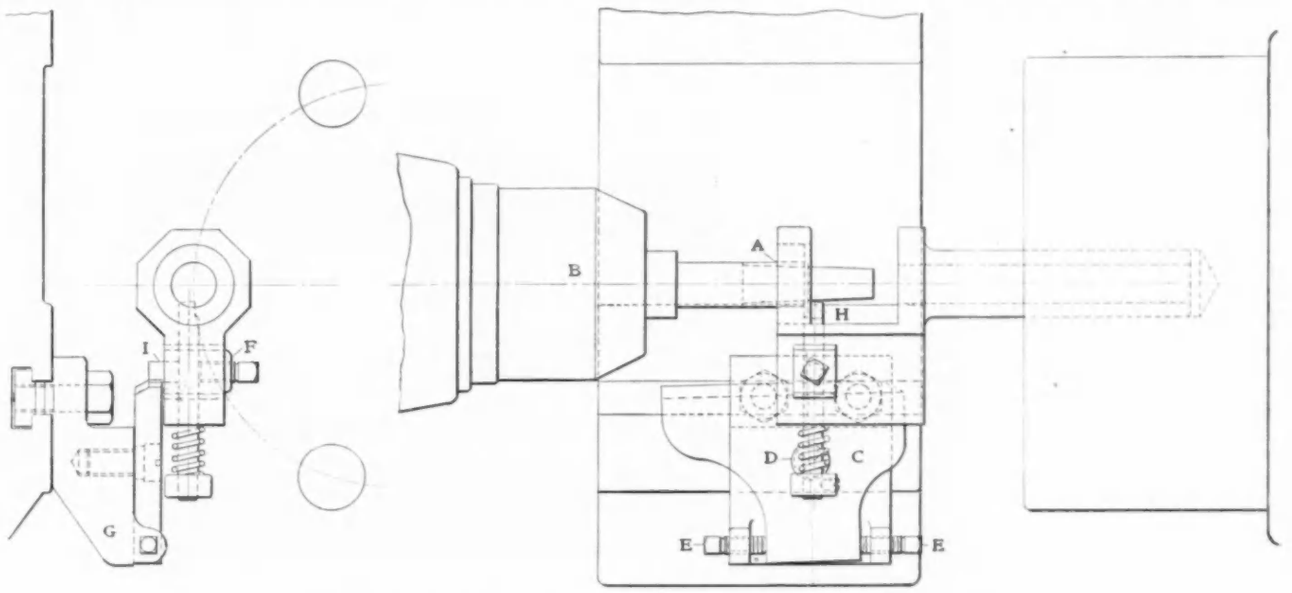
No profits are paid until the work is inspected and found to be correct. Direct piece-work prices are given to all except the workman on boring and assembling, and to him the price allowed is proportionately more liberal and instead of giving the total saving to him, a varying percentage only is his share. This latter scheme permits of testing and of some experimenting.

Taper-turning Attachment for Automatic Screw Machine

By J. P. Brophy*

The drawing shows a taper-turning attachment which may be used in any of the screw machines built by the Cleveland Automatic Machine Company.

Taper pins of small diameters are usually made from drawn stock, and when using this style of tool we bush the end at *A* to steady the stock against the pressure of the cut. If the diameter of the bar is large, either drawn or rough stock, it is not necessary to use steady rests.



TAPER-TURNING ATTACHMENT FOR THE AUTOMATIC SCREW MACHINE

With this attachment pins can be made with the small diameter of the taper on the outside or toward the chuck hood *B*. The steel plate *C* is ground on both sides, and swings at point *D*, and by the adjusting screws *E E* can be readily changed for any taper. At the edge of steel plate *C* there is a hardened pin, coming in contact with it, which is a part of sliding block *F* carrying the tool. Block *G* is machinery steel, case-hardened, and ground top and bottom. *H* is the tool which is advanced when pin *I* comes in contact with the side of hardened plate *C*, as represented. The spring shown offers resistance to the tool as it is advanced and carries the tool in a backward position when the turret recedes, after the taper is finished.

This turning attachment is extremely simple, and the adjustment for the various tapers takes only a few minutes. The attachment is generally used on the front of the cross-slide and the cut-off tool on the rear. In a great many cases it is used for the manufacture of parts that are not taper pins, but which, nevertheless, require a taper. It may be possible for the outside of the piece to be milled from the turret, drilled and threaded; at the same time, by using this attachment we can turn a taper on the rear of the part close to chuck hood *B*.

It will be understood that this tool can be used as a universal device for making parts of various shapes and for producing a taper when necessary.

*General superintendent, Cleveland Automatic Machine Company.

Mechanical Powderless Gun

A rapid-firing powderless gun has recently attracted considerable attention, and the performances of a ten-inch model, if carried out in actual warfare size, point to a greatly improved weapon. The gun is fired by centrifugal force by means of revolving a large wheel with a crank. The bullets—not shells, such as are used in other guns, but simply balls of lead or steel—are poured into the gun, the wheel revolved, and the bullets are fired out in a steady stream at a rate that the inventor claims will approximate 50,000 shots a minute by utilizing a 50-horsepower motor for revolving the wheel. The gun is of brass and looks like a meat chopper or cylindrical pencil-sharpener, and its accuracy of fire is claimed to be almost absolute. It is said that the inventor of the gun got his idea from a flywheel burst.

A somewhat similar device, or at least one reported to be capable of the same results utilizing somewhat similar methods was brought to public attention some years ago and was noticed in these columns.

Practical Points in Cylindrical Grinding

Economical Production of Work by Roughing Out in the Lathe Prior to Grinding, and the Advantages of Higher Work Speeds

BY J. J. THATCHER*

The economy of manufacturing parts with the grinding machine has been dwelt on at some length in these columns. In manufacturing, the lathe has been reduced to the field of roughing out work, but has been made a more powerful machine tool, capable of more rapid work than it was previous to the development of the grinding machine; high-speed steel has also added considerably more to the output of the lathe. Obviously, this higher speed in lathes is at a sacrifice of accuracy and finish, but this loss is not detrimental when pieces are finished to size on the grinding machine.

The Field of the Lathe

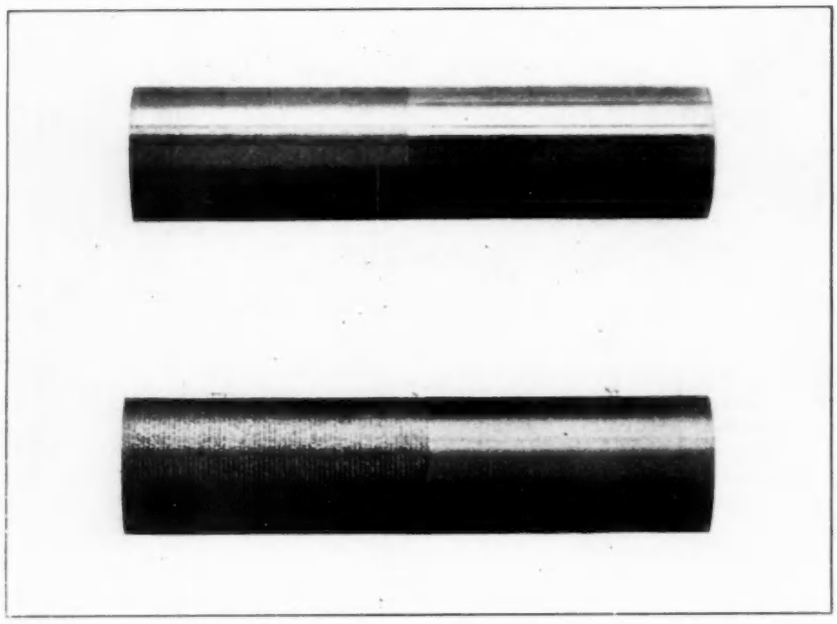
The lathe has yet an undisputed field for roughing out work and removing scale, which a grinder cannot do economically for several reasons. If the piece is to be ground from the rough, the centering must be done more carefully in order that the scale may be removed equally from all sides; for if it is not, the wheel will invariably crowd the work away when it comes in contact with the scale. It has been the experience of the Brown & Sharpe Manufacturing Company that grinding the scale is more expensive in wheel wear than the extra handling occasioned by lathe work. This excessive waste of wheel comes from the direct contact of the wheel with the scale, which tears the abrasive away faster than the clear metal would; incidentally, this requires the frequent use of the truing device to keep the wheel in shape, and proves a prolific source of waste of abrasive material as well as of the operator's time. Unequal strains exist in pieces just under the scale; a lathe removes all of these in one cut, which a grinder cannot do. These strains, when removed from one side and not from the other, owing to imperfect centering, will cause pieces to bear harder on the wheel on one side than the other. This increases heat on that side, which expands one side of the work, aggravating the trouble originating from the scale. Turning up work on the lathe in lots, then grinding afterward, gives pieces a chance to "set" and insures an accuracy in grinding that is permanent.

As a rule, foundry men and blacksmiths are hardly willing to work as close to finished sizes as would be required in order to leave an economical amount of stock for a grinder to remove. If small allowances are made for finish, there is always a large number of pieces that will not "finish out." This loss will soon more than offset the extra stock for finish and the cost of lathe work in roughing out.

Finished Work

There seems to be some difference of opinion among different manufacturers of machine tools as to what constitutes a finished piece of ground work. Some concerns seem willing to let their shafts go with rough bearings even to the extent of having the feed marks of the grinding wheel show on the spindles, shafts, etc. The variations in hight of these ridges and depressions is very slight; in fact, it cannot be calipered, but the fact that their presence has been claimed as an advantage as a means of lubrication would indicate that they are there and while oil would tend to equalize the pressure on the bearings, the fact that the high places soon polish would indicate that they are carrying more than their share of the load. Avoiding this defect in grinding produces an easier running machine and materially adds to the life of the bearings by producing artificially that glazed condition on the steel member of the bearing, which is noticeable on the cast-iron member after the bearing has been in use some time. The wearing qualities of a glazed bearing are well known to all engineers who have had experience along these lines.

The knowledge will come to some manufacturers as a surprise when they have produced so perfect a bearing, that oil is not a mysterious substance that will permeate anywhere, but on the contrary requires a space that must enter into their calculations in dimensioning the parts of their machines. An average bearing of about 2 inches diameter, running at a speed of about 100 revolutions per minute, will require from one to one and one-half thousandths of an inch for oil space; heavy pressure or high speed or larger diameter will require more space.



GRINDING-MACHINE AND LATHE WORK

Limits in Grinding

In working to accurate dimensions, it is necessary to establish limits between which the ground piece of work will pass inspection. This should be done in the designing department, where the conditions under which the piece is used are known. For ordinary manufacturing purposes, a limit of half a thousandth is sufficient; that is, a piece of work may be one quarter of a thousandth larger or smaller than the dimension given. This is sometimes referred to as a quarter-thousandth limit, but a moment's thought will show that the two limiting dimensions for the grinder operator to work to are half a thousandth apart. If for any reason a closer limit is demanded, as for instance in forcing a hardened-steel shell

*Designer of grinding machines, Brown & Sharpe Manufacturing Company.

on a hardened-steel spindle, it must be understood that the grinding operation is more expensive and that the construction of these parts is enough better to warrant the outlay.

Work Speeds

Vital to the economical production of parts with the best possible finish is the speed at which the work is revolved as it is brought into contact with the abrasive. On grinders as originally made by the Brown & Sharpe Manufacturing Company, the work revolved very much faster than is now considered correct. It was discovered that a new surface was presented to the wheel much faster than the wheel could cut it away. This naturally caused a crowding of the work with a resultant inaccuracy. To obtain the best results the work should be run at such a surface speed as it comes in contact with the cutting particles of the grinding wheel as to cut without crowding the work away from the wheel beyond what can be overcome by very slight counteracting pressure applied by the use of work supports. Our experience has led us to so design our machines as to present a new surface to the wheel at a rate of 40 to 100 feet per minute. Cast iron is generally fed a little faster than steel, but it is very difficult to give definite figures for cast iron, as different pieces of the same job taken from different pourings of the foundry require different speeds. Work of small diameter, about ½ inch, owing to the small arc of contact, is revolved at a relatively faster speed, say, 80 feet per minute, while work 2 or 3 inches diameter with longer arc of contact is revolved at about 60 feet per minute. As these speeds are inversely as the speeds resulting from varying diameters, a great range of work speed is necessary on grinding machines.

Comparison of Speeds

The inconsistency of using very slow work speeds with rapid production is obvious when given a little thought, and more obvious when given a trial. Take, for example, a piece of steel 4 inches diameter and 45 inches long, using a surface speed of 6 feet that I have seen recommended in the columns of some of the technical publications. The circumference is about 12½ inches, and the work would make approximately six revolutions per minute. As the traverse of the wheel along the work cannot exceed the width of the wheel per revolution of the work, the traverse would not exceed 12 inches per minute, estimating a 2-inch width of wheel for this size of work. With an average depth of cut of 0.002 inch, it would require eight passages of the wheel across the work to reduce the diameter of work 1/32 inch. This would take 30 minutes, disregarding time for placing the work in the machine, truing up and finishing the work. Using a surface speed of 50 feet per minute on the same piece with the same depth of cut and about two-thirds of the width of the wheel, or 1¼-inch travel per revolution of work, we can make the eight passages in six minutes, and at each traverse the surface of the work will be very much smoother; in fact, for all ordinary purposes an allowance of about 0.0005 inch for final finish will be sufficient, for which the table travel may be slowed down to about one-half or one-third of its original speed. Means for accomplishing this change quickly is provided for on the Brown & Sharpe plain grinding machine by a lever in the front of the machine. With the slower rate of feed and consequently coarser cut, it will be found necessary to leave at least 0.0015 to 0.002 inch for finish; thus, both the roughing and finishing operations are unnecessarily prolonged by the use of very slow work speeds.

Surfaces Produced in the Grinder and Lathe

The half-tone shows examples of grinding and lathe work. The upper piece was ground its entire length with the same grinding wheel on the same machine. The only change was the relative speed between the work and the wheel, and shows the difference between an incorrect and correct speed of work. The lower piece is lathe work and illustrates rough and smooth lathe work. The smoother end was considered good enough for a bearing previous to the use of the grinding machine. The rough end is considered good enough to send to the grinding department for finishing, as the grinding wheel will remove all ridges in one cut.

Surface Speeds for Jeweler's Rolls and Machine Parts

The fact that the higher speeds of the work produce a better finish, regardless of time consumed, is well illustrated in the grinding of jeweler's rolls. As far as I know, the only way yet devised by which a surface satisfactory to the demands of the jewelers can be produced is by grinding and lapping with a surface speed of about 175 feet per minute. It has been my privilege to visit some of the representative manufacturing concerns in southern New England where grinding has become an established process. In all these shops, the requirements are for the very highest order of grinding, and the methods used are largely the result of their own experimenting along the lines of quality of work produced and the quantity of output. At the works of a large woodworking machinery company, cast-iron rolls, mounted permanently on steel shafts, are ground at a surface speed of 80 feet per minute. Cutter heads designed for high speed in the wood planers are rough-ground on bearings at a speed of 25 feet per minute; these are later finished at a speed of 55 feet per minute. Steel studs are ground at a surface speed of 60 feet per minute.

At the works of a prominent machine-tool manufacturer spindles are being ground at a surface speed of 175 and 220 feet per minute. These two speeds are on two different diameters of the spindles. The difference in the two speeds is not considered of enough importance to warrant changing the speeds of the headstock. These higher speeds are essential to the production of work of a grade on which they are willing to stake their reputation. On some machinery-steel shafting, 1 inch diameter, they are using a speed of 70 feet per minute for both roughing and finishing.

At the works of a well known lathe manufacturer the lathe spindles are ground at a surface speed of 80 to 145 feet per minute according to diameter. Some steel forgings 1⅜ inches diameter are ground at a speed of 110 feet, and steel shafting at 100 feet per minute. These high work speeds are maintained to produce the finish desired for their particular class of work, also to facilitate the economical manufacture of parts.

The Wear of the Wheel

Experience, based on careful observation and extended experiments, shows that a grinding wheel wears away directly in proportion to the amount of stock it removes regardless of the speed of the work; that is, the cubic inches of metal removed from the work and the cubic inches of grit worn from the wheel in the operation of grinding seem to bear a constant ratio which is not affected by high or low work speed; it must be understood that each different composition and hardness of work, and bond and grade of wheel has its own ratio. The faster work speeds, as just noted, permit of more work being done in a given time, and, therefore, there is a more rapid wearing away of the wheel; hence, the mistaken idea that fast work speeds wear away the wheel more rapidly than slow work speeds.

Slow Work Speeds and Wide Wheels

It may be mentioned here that the very slow work speeds, say, 20 feet down to 5 or 6 feet, require an extra wide grinding wheel, in order to get a table travel suitable for producing commercial work. This wide wheel requires a massive base, which means a larger machine than would be required for the same work with higher work speeds. The wider grinding wheels also require proportionately greater power to drive them. The grinding department at the Brown & Sharpe works is served with a 7-inch belt driving the main line shaft, from which are belted over 100 grinders besides an elevator, two blowers and pumps.

The wide wheels crowd the work excessively against the rests. To overcome this, some manufacturers have gone back to solid work rests; these have to be adjusted at each passage of the wheel to follow up the work as it is reduced in

diameter. This following up is automatically accomplished with the use of the well known spring-back rests and automatically checked when the work has been reduced to the required diameter.

Wheel Velocities

It has been the practice of the Brown & Sharpe Manufacturing Company for several years to run the grinding wheels somewhat faster than is customary with most companies using grinding machines. With all the precautions taken that are recommended by the wheelmakers, there seems to be no excuse for any accidents. The grinding wheel should not be forced on its arbor; the collars or flanges retaining the wheel should be cushioned with rubber washers and the flange brought up with equal pressure on all sides simultaneously, thus avoiding cramping. It is the best practice to true up the grinding wheel on the periphery at a slower speed than that at which the wheel is finally used, and the sides of the wheel may also be trued up if necessary. When this is done, a speed for grinding of 7000 or 8000 feet per minute is not excessive or dangerous. The periphery of the wheel should again be trued off with a diamond at the working speed before it is used. Finally the wheel is effectually guarded with a heavy hood surrounding nearly three-quarters of its periphery. With these precautions, an accident has never happened at the Brown & Sharpe works, and actual statistics will prove that the grinding machine is one of the safest machines with which we have to deal.

Pins and needles represent an industry far greater than most people are apt to believe. A census for a recent year showed a total output of 154,314,512 needles and 136,887,782 gross of the various forms of pins, which together represented an estimated commercial value of $3,208,561, giving employment to about 4000 wage-earners of about equal numbers of men and women.

A Gear System with Unequal Addendums

By Fred Mill

The designing of smooth-running gears for high velocity has come more to the front in later years and is leading the designer to go deeper into details. Mr. Lasche, of Berlin, has given some useful and interesting information on the subject, which I have followed for laying out the templets for my bevel-gear shaping machine. I will give some details of Mr. Lasche's method, but for the complete view of the subject, I refer the reader to the original. "Electrisher Antriebmittels Zahnradubetragung," in *Zeitschrift des Vereins deutcher Ingenieure*, 1899, page 1417. Also to K. Büchner, "Beitrag zur Kenntnis der Abnutzungs and Reibungsverhältnisse der Stirnräder," in *Zeitschrift des Vereins deutcher Ingenieure*, 1902, page 159.

The involute system is generally used and will unquestionably be the only system used on account of certain advantages it has over the cycloidal system. Fig. 1 represents a gear construction which is generally used. Fig. 2 represents a gear construction from the Algemeine Electricitäts Gesellschaft of Berlin and which has proved for a number of years to be a success on account of better wearing qualities. In this construction Mr. Lasche decreases the addendum of the driven gear and increases the addendum of the driving pinion, which shortens the line of contact in front of the line of centers and lengthens the line of contact in the rear. This lessens the sliding friction between the flanks of the teeth and diminishes the wear, because at the time the point of contact is in line of centers, there is no sliding, but only rolling action between the tooth flanks.

Figs. 1 and 2 illustrate the relative sliding action upon the tooth flanks in spots laid out thereon. Equal numbers work together during a period of contact. In Fig. 2 the tooth profile is nearer a shape of equal bending moments and consequently stronger for the same pitch. Thus a smaller portion can be employed and, therefore, shorten the line of contact in front of the line of centers still more, and decreases the sliding action and wear between the flanks. The flanks of the teeth, even for a gear with a smaller number of teeth, will not be undercut and the profile is a full involute on the pinion as well as on the gear.

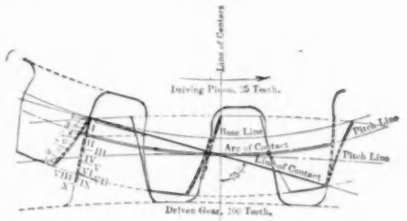


FIG. 1

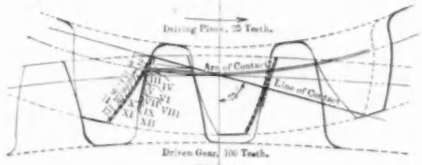


FIG. 2

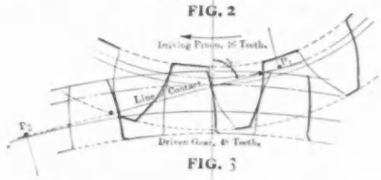


FIG. 3

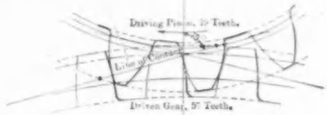


FIG. 4

DIAGRAM ILLUSTRATING THE GEAR SYSTEM WITH UNEQUAL ADDENDUMS

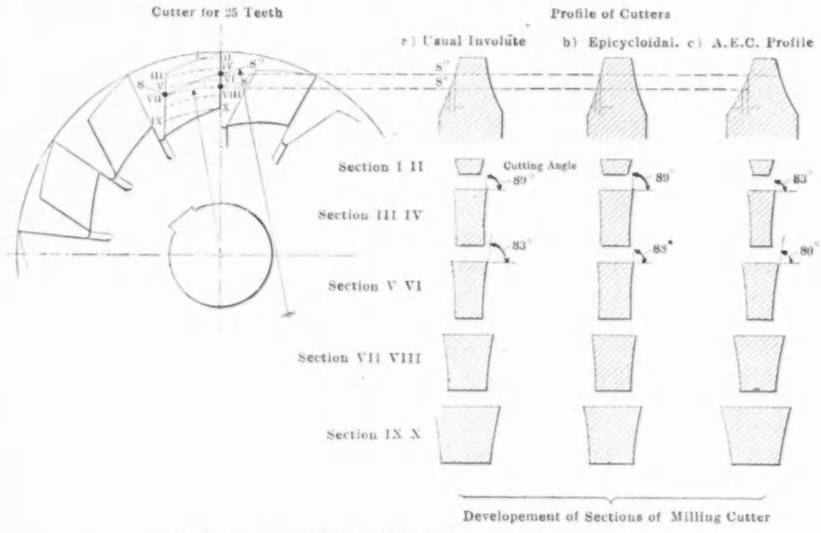


FIG. 5. COMPARISON OF PROFILES OF GEAR CUTTERS

The milling cutters for cutting a gear with a small number of teeth have too little side clearance and are difficult to keep sharp. They swage their way through the material on this account, whereas in the late construction the milling cutter will make a clean cut. Compare profile of cutters, Fig. 5, and note the side cutting angles at the different sections. Mr. Büchner has given a description in one of the papers above mentioned of a method in which the unequal wear on the tooth flanks of gear teeth can be avoided, in order to retain as long as possible the original tooth profile. By increasing the number of teeth in pinion and gear the line of contact is shortened still more. The gear construction, Fig. 4, can carry the same load as Fig. 3, but the former has better wearing qualities. In general the line of contact in front to the line of contact in the rear of the line of centers, should be in proportion to the ratio of the driving to the driven gear. Care should be taken that the line of contact is inside of line $P P_2$, as in Fig. 3.

Making Tools for Formed Gear Cutters and Hobs*

The Application of Templets, Fly Cutters, Formed Tools and Fixtures to the Solution of the Formed Cutter Problem

BY WARREN E. THOMPSON

The making of formed cutters for milling duplicate parts of machinery is a subject of greater or less interest to every machinist and manufacturer though not clearly understood by many. The cost of making formed cutters, or rather the first cost of fitting up tools to make them with, prohibits many concerns from doing this class of work. Many of the large machine manufacturers, however, have a special department set aside for this work and employ men who are specialists on this class of tool.

The problems connected with the different cases I have selected for illustration are in their simplest form. A knowledge of trigonometry is not necessary to solve the problems constantly arising but a set of tables for solving both right- and oblique-angled triangles is an absolute necessity. These tables, tables of the natural functions (sines, tangents, etc.,) constitute practically all the data necessary to solve any problem connected with the making of formed tools.

The Stock for Tools

All tools usually start in the cutting-off department and in most cases this is in a special room equipped with different forms of cutting-off saws and turret lathes. The steel used for formed tools and cutters should be the best that can be procured. Any of the different brands of high-grade steel are suitable and should be kept in stock in various sizes.

The cutter blanks, especially, are most economically sawed and the holes should also be bored in this department. The blanks are then ready for turning on a plain mandrel.

Formed tool stock is usually sent from the stock room to the planers and its four sides planed before cutting up, the cost being reduced greatly by this system. After it is returned to the saws and cut into standard lengths, it goes to the milling department where the ends are milled at an angle of 20 degrees with the face, the stock being held for this operation in the special fixture Fig. 1. The stock then goes to the tool room all ready for the toolmaker to finish an order. The stock in this state is usually about 6 inches long, ⅞ inch thick and in varying widths from ½ inch to 6 inches. The sizes in common use range up to 2½ inches but in some cases tools are made 8 inches wide.

Fly-tool Stock

The stock is listed, stamped with the steel symbol, and placed on shelves having the size on brass plates in plain sight. A small amount of stock is also prepared for fly-tools. This is made from ⅜ to ⅝ inch thick and of varying lengths and widths. Stock with two sides planed parallel of varying widths is the most economical as both ends may be used. Fly-tool holders of the Brown & Sharpe pattern with varying lengths of hole up to 6 inches should be at hand.

Machine Equipment

The milling machine used should be strongly built, with all adjustments easily and quickly made and have the feed dials

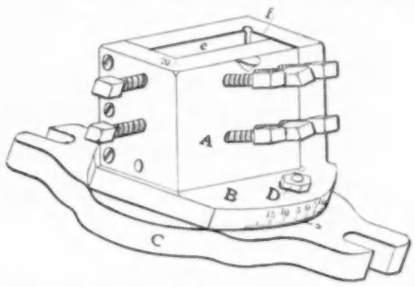


FIG. 1. FIXTURE FOR MILLING AND PLANING FORMED TOOLS

register accurately; the table should swivel to allow of planing or milling at an angle with the line of motion of the table, and the spindle should be rigidly supported in the most convenient manner to permit ready changing of arbors and holders. One feature missing from milling machines is a high-speed feed for planing. This can be easily remedied on the Brown & Sharpe No. 1 machine by putting a small pulley on the end of the feed-gear shaft close to the change-gear box and belting from the countershaft.

A means of holding the spindle from turning when planing must also be provided. The best plan is to have hardwood blocks sawed to fit one step of the cone (usually the second largest) and the body of the machine directly in line, with a hole drilled in each block to receive a bolt to tighten them by. The blocks are always in place on the machine and can be adjusted in an instant.

A good surface and tool grinder are also necessary for special grinding and a strong back-geared lathe is needed for testing gear tools and miscellaneous turning.

Vise Jaws, File Blocks, etc.

The benches should be well lighted and the windows have white curtains heavy enough to reduce the sunlight.

Strips of belt leather cemented to the vise jaws are better than brass jaws for cutter work.

A filing block like Fig. 2 is very convenient. A casting is made and a thumb screw put in. Hardwood blocks are sawed to the shape shown and driven into the iron clamp. This block is quickly removed from the bench when desired and the cost is practically nothing after the first installation.

The holder shown at Fig. 3 is screwed to the top of Fig. 2. Large tools are clamped in it, thus relieving the hand of the weight when filing, at the same time leaving the tool free to follow the line of direction of the file. It is not good practice to file-finish a form in the bench rise as it is held rigidly and hence has no chance to follow the motion of a file which is never in a straight line. It is not impossible to file a surface flat and straight, but it is more economical to have a surface free to move when file-finishing.

Stones and Laps

A good variety of stones of all kinds should be kept in the stock room and a set furnished each man. Stones of the carborundum variety are useful but in many cases the finest hones are necessary to produce the requisite edge. Practically all tools change to a certain extent during the process of hardening, and, as they are usually of irregular shapes, the most economical method of removing the stock to the required limits is to stone it away. A planed iron plate with box and cores should be kept for lapping the stones to shape when they become worn. Water and emery may be used successfully but the best medium is sand and emery dry. Stones can be lapped straight and flat with little loss of time by using a liberal amount of sand and emery and the block is in good condition for a long time if water is kept away from it.

Gasolene or benzine should be kept in safety cans in liberal quantities and special cans furnished for use at the rise. These special cans are best made in the form of a truncated cone with a heavy lead bottom to prevent their being easily upset; they should have a capacity of about one-fourth pint. The time saved by using this liquid on stones is of such importance that the cost of gasolene should not prevent its being used. The stones do not clog, chip, or wear anywhere near as fast as when used dry and time lost in running to the lapping block is reduced to a minimum.

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Methods of Forming the Tool

The number of operations necessary to produce a finished form tool varies from three to five on ordinary work and may run as high as ten on special orders. On one form it may be only necessary to mill the form, harden it, and grind the face and sides; again the requirements may necessitate a male and female templet, two fly-tools, a master tool and the operations of planing, filing, hardening,

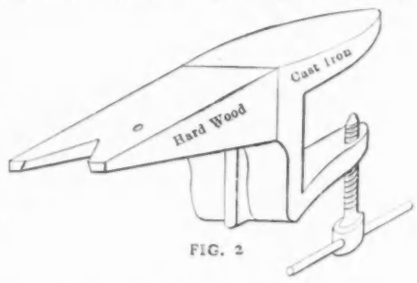


FIG. 2

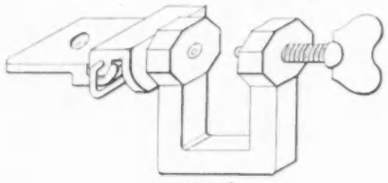


FIG. 3
FILING BLOCKS

stoning and grinding the formed tool, this depending entirely on the nature of the work to be produced.

Duplicating a Gear Cutter

The pinion represented at *A*, Fig. 4, has a special form of tooth and a cutter was wanted to cut this form as near as possible. In the actual case taken as an example the cutter used to produce the pinion had worn away on the point on the side *b* so it was impossible to use the space as a templet to make a fly-tool by. The side *a* was of the correct form and side *b* was approximately correct from *x* to *y* as shown by the finish left by the cutter used.

A thin piece of sheet zinc was first filed to fit the space exactly in one position by carefully tapping with a light hammer and removing the high spots. Zinc being a soft metal can be quickly fitted to a form by tapping a little, to drive it into the form, filing away the upset points, tapping again and so on until the final tapping practically fills the form, while a templet of sheet steel must be entirely file-fitted.

Male and Female Templets

This templet thus made is shown at *B*, Fig. 4. Another piece of sheet zinc *C* was filed to fit *B* in the position shown. Thus a form of *C* was made exactly the same as the cut in the pinion. Now as *C* was reversed on *B* the effect shown in Fig. 5 was produced. The templet *C* was then filed away as shown by the dotted lines until side *b* was a good fit to side *a* of templet *B*, and there was no shake when the two pieces were put together in either position. This filing and fitting had to be carried on very carefully, filing only the side *b* of *C* where it came in contact with and prevented *B* from bottoming and fitting *C* without shake. The space in *C* was then the same as that of the gear with the exception that both sides were alike and had the correct form. Templet *C* was then used as a gage to make the fly-tool by. In order to get both sides of the fly-tool exactly alike, a master tool *D*, Fig. 6, was made to fit the correct side *a* of the templet *B*; the method was as follows:

Making a Master Tool

A piece of 3/8-inch stock the required width was selected, the face coppered, and the outline marked on its face. It was then handed to an apprentice who rough-milled the stock away in a bench miller, at an angle of 20 degrees under and around the outline. The tool was then rough-filed to fit the templet by the same apprentice and handed to a good toolmaker. The lines 1, 2, 3, 4, etc., were scratched as shown a short distance apart. The use of these lines becomes apparent when the tool and templet are placed together and viewed by transmitted light. The high spots are easily noted and filed away accurately, whereas if these lines were not used many low spots would also go owing to a lack of knowledge as to just where to file. About 5 degrees clearance was given the cutting edge to allow of its cutting freely.

Filing

In filing a form of this kind the file should be held at the end away from the tang, with the latter end up and should cut on the down stroke, not up. The reasons for this are plain and conclusive. Practically no bur is thrown upon the face which will prevent its lying flat on the glass used to hold the templet and tool in the same plane, and more force can be exerted on the file, as the work is held down on the block instead of being forced up by an upward cut. It requires very little pressure of the hand to hold the work steady on the block when cutting downward, but if the file is held by a handle underneath the work and forced up it is practically impossible to hold the work against a fair cut.

When the tool *D* was filed very close to the curve *a* on templet *B* it was hardened, the face ground, and then stoned to a close fit to the templet. The relation of the side of the master tool to the center of the form is immaterial within certain limits as this is regulated by swiveling the machine vise when milling, or, as it is called, "flying out" the fly-tool *E*. After the master tool is hardened, lines cannot be scratched on its face so etching varnish is used, and the lines etched. Thick shellac is a very good material, easily applied, and able to withstand the solution of nitric acid generally used.

The Fly-tool

We are now ready to make the fly-tool or tool used in the milling machine to produce the formed tool. This tool *E*, Fig. 6, coppered, laid out, and milled the same as the master tool, leaving only a narrow edge to finish. The method of "flying out" this particular tool was substantially as follows:

The fly-tool was bolted into a proper fly-tool holder in the milling machine, and packed up until the face was in a plane intersecting the axis of the spindle. The fly-tool holders commonly used for this kind of tool have the holes at an angle of 5 degrees with the axis of the spindle to give the tool side clearance, which is necessary when making gages. The master tool was clamped flat in the milling-machine vise and the knee of the machine adjusted until the faces of the fly and master tools were in approximately the same plane. The difference in form caused by the faces being at an angle of 5 degrees with each other is so slight that it is seldom rectified. The vise was then swiveled until the form was about square with the center line, and one side of the fly-tool "worked out," or in other words the master tool was fed into the path of the revolving fly-tool until it cut the full form.

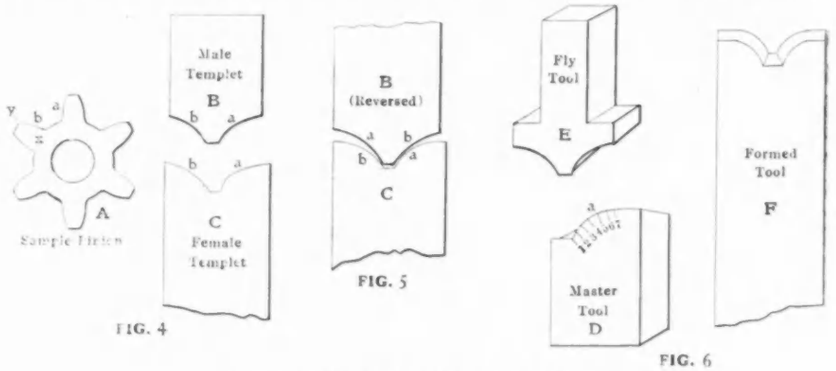


FIG. 4 FIG. 5 FIG. 6

TOOLS FOR DUPLICATING A GEAR CUTTER

Reversing the Fly-tool

The edge thus made on the fly-tool was coppered and the tool reversed in its holder for the "flying" out of the opposite side of the form. The master tool

was fed in until it just scraped the copper from the end of the fly-tool and then fed crosswise until the proper tooth thickness was obtained, at the same time, templet *C*, Fig. 4, was constantly tried to test the form. In this case the form was not correct the first time; the vise was then swiveled to allow for the difference in form and the cycle of operations repeated. The third trial gave a form that fitted the templet and the tool was then taken out and hardened.

Fitting to the Templet

If a form of this kind does not fit the templet when the proper thickness is obtained, the vise is swiveled whichever way the tool is out as regards width of form at the top or bottom. If the tool is wide at the top of the curve when the point touches the bottom the master tool should be turned to cut this part before cutting the point, and *vice versa*. The tool must then be "flyed" out again and the operations continued until the correct result is obtained.

After being hardened and having its face ground the tool was tested by flying out in thin sheet brass and stoned until it reversed in its own impression, both sides fitted the master tool, and it was a good general fit to the templet. This process gives a fly-tool as near perfection as it is possible to make it and is the method used by successful cutter manufacturers.

The Light Tests

Small pieces of plate glass of varying sizes with different thicknesses of paper carrying one-half of each side are necessary for accurate fitting and testing of parts. Light passes through exceedingly small space, and the object is to make a fit that will exclude light when forms are matched together, flat to the glass, and reviewed by transmitted light. It is not necessary to carry the form to a point where all light is excluded, as this is practically an impossibility, but the edge as reviewed should present one even line, not a line closed in patches and open in others.

Special Fixtures

Strong fixtures of the form shown in Fig. 1 should be made for milling and planing formed tools. There should be both 20- and 22-degree fixtures of this kind. Most tools will be made with 20 degrees end clearance, which is sufficient for any straight backing off, but in cases where the tool has to clear a warped surface such as the thread of a hob, the 22-degree fixture should be used and the tool planed with side clearance.

The fixture in Fig. 1 consists of three parts, *A*, *B* and *C*. The plate *C* has a recess at the center about 4 inches in diameter into which a hub on *B*, concentric with the turned base of *B*, is turned to a nice fit; and an inverted T-slot is turned to take the locking nuts *D*. The base of *B* is graduated on both ends to allow rapid setting for side clearance. The reason for making the parts *A* and *B* of the form shown is to keep the gaging surfaces from springing when excessive pressure is exerted on the set-screws. The opening to receive the tools is made about 1 1/16 inches wide and of a length sufficient to take in the standard

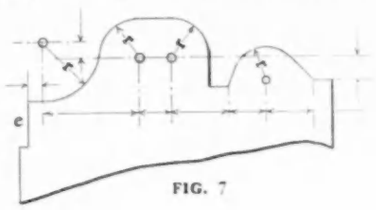


FIG. 7

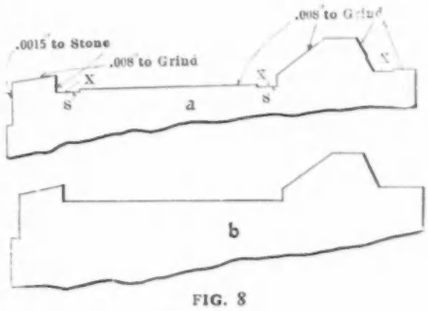


FIG. 8

FORM TOOLS

widths of stock. The depth is made about 4 inches and a strip of hardwood is fitted into the bottom to prevent damage to a form when dropped in. A hole is drilled through the end pieces at the bottom of the slot to drain the oil away.

Preparing the Formed Tool for Planing

The process of planing the formed tool is practically the same for all tools and

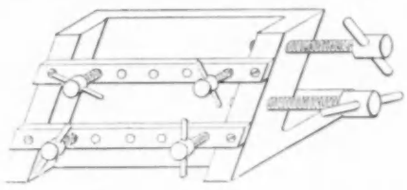


FIG. 9. GRINDING FIXTURE FOR FORMED TOOLS

is simple and quick. It is made cheaper in the end to plane tools out (as no special skill is required) than to have them filed by expensive bench hands.

A piece of stock is coppered and the outline of the fly-tool is transferred to it. One way of transferring is to place both fly-tool and stock in their respective holders in the milling machine with the face of the fly-tool in contact with the back of the stock and scribe the outline true and square. The fly-tool is removed, a milling cutter substituted and the form milled close to the line. In case side clearance is desired, allowance must be made in scratching the outline and the fixture swung the requisite number of degrees for each side when milling or planing. When planing, the table of the machine must be swiveled the same number of degrees as the fixture, but in the opposite direction to bring the faces of fly and formed tools into parallel planes. If this is not done the form will not be of the required shape.

Side clearance is put on tools having a cutting edge perpendicular to the axis of the cutter and also on hob tools particularly, to prevent interference with the sides of work or thread. When possible the side clearance is all on one side to allow for the tool being ground without changing its shape. Most gear cutters of large pitch are given side clearance and tools for these have a clearance of from 3 to 5 degrees on each side. A form of a width greater than the cutter is usually made on side-clearance tools, especially gear tools, and the cutter is sized to tooth thickness by moving the formed tool laterally. A guide edge is milled on the left-hand side of all unsymmetrical tools to set the form in the proper relation to one side of the cutter as shown at *e* in Fig. 7. This is always done after the form is planed and filed.

Planing the Form

After milling, the form is ready to plane and the method of procedure is as follows: A fly-tool holder is placed in the milling machine, the fly-tool inserted and clamped, and set until its face is parallel to the face of the formed tool blank. Tightening the wooden clamps on the drive cone prevents a change of position and the overhanging arm center is used to prevent the tool from springing away from the cut. The work is then fed up to the fly-tool a few thousandths at a time until it cuts a clean surface and then the form is scraped with a chip of about one-quarter thousandth inch at a cut, in two to four cuts. I have always made a practice of dropping away from the work on the return stroke as this often saves making a new fly-tool and certainly keeps the edge from chipping or grinding away.

Grinding Tools

In many cases, where the tools have flat, straight, parallel surfaces, most of the work can be milled and ground after hardening without planing. The tool shown in Fig. 8 was milled as shown at *a* and the corners *x* planed with a small tool, as it is not possible to grind a sharp corner economically. Allowance was left for grinding as shown and the tool hardened. After hardening all tools are ground on the face to sharpen them and the bur rubbed off with a piece of zinc or other soft metal.

This particular tool, after face-grinding, was finished in a Brown & Sharpe adjustable swivel vise. The edges square with the side of the tool were set in the desired position by the points *S S* and the vise swiveled to 20 degrees, which in this case was the end-clearance angle. These

edges were then ground until they coincided with the corners *S S*, not to be reduced. To grind the angles it was necessary to turn the tool in the vise until the edge was at the proper angle with the tackle measured from one of the edges already ground, usually the longest, and the vise swiveled until the wheel ground in the same line as the milling. If the vise was set over to 20 degrees the angle of clearance would be more than called for and the tool could not be ground without changing its shape. The correct angle could be quickly figured but it is usually sufficient to set by the milling cut. All of the angles were thus set and ground straight and true. The tool after grinding presented the appearance indicated at *b*, Fig. 8.

A Grinding Fixture

In many cases the fixture, Fig. 9, is used in grinding the form. It consists of an angular casting with the guide surfaces planed and two straps bolted on the latter carrying set-screws as shown. The tool first has to be set in a flat vise and, taking the last case presented as an example, the corner surfaces *S S*, set square with the tackle of the machine. The left-hand side is used as the guiding edge and is ground straight and square with the corners of the form not to be ground. The tool is then set up in the fixture, Fig. 9, and the straight surfaces ground, afterward finishing the angles in the swivel vise as before described. This is the cheapest method as the left-hand side of all tools has to be ground before the tool is ready for backing off.

Universal Vise

For milling odd shapes a Brown & Sharpe Universal toolmaker's vise is useful. When milling or planing a tool the face of which is at an angle to the table of the machine it is customary to use the elevating screw dial when working out depths, and figure the distance to move perpendicularly by the following formula:

Let *C* equal the depth of cut as measured on the face of tool,
D equal the angle of clearance,
E equal the distance to move the knee as indicated by the elevating dial.

Then *E* equals *C* (cosine *D*). This is called the "cosine depth."

Depth Gages and Other Tools

When planing or grinding parallel surfaces, it is much easier to hold the depth gage on a flat surface and measure from this than it is to measure two sharp edges, especially when a micrometer depth gage is used.

A vernier depth gage is the best thing of its kind for measuring the depth of parallel surfaces. The end of the blade is made of such a width that parallelism can be determined without first using a square, and very accurate measurements made. The micrometer depth gages are not at all useful for formed tools for this reason. A vernier depth gage is also used considerably for laying out work on zinc accurately and is far superior to a hight gage, which is very seldom, if ever, needed.

Vernier calipers are necessary to measure surfaces that cannot be measured with micrometer calipers. Vernier scribing points can be purchased from the makers of calipers and are an important addition to the equipment, as by their use circles of any diameter within the limits of the vernier can be drawn very exactly. Bevel protractors graduated to read to a small fraction of a degree are necessary and the very best should be purchased.

Fine Scales

Fine scales are hard to find in the stock of dealers carrying tools and should be ordered direct from the makers. Scales as ordinarily purchased have the graduations entirely too coarse for fine measurements. It is possible, however, to send to the makers of reliable measuring tools and purchase a tempered scale with etched graduations not over two thousandths of an inch wide at a very slight cost over the ordinary scales. The most convenient form to purchase is that having a triangular cross-section with graduations in 100ths, 64ths and 16ths. Measurements on a plane surface can be made very accurately and quickly with a scale of this description and it is invaluable for setting dividers.

Small hardened and ground plates with the four edges square are a valuable addition to a toolmaker's equipment for use in filing edges straight and square. Standard squares and small tools should be procured by every man intending to perfect himself at the business. Borrowed tools are not to be depended upon and borrowing is a bad habit to get into for this reason.

Disk and Plug Tools

Disks and plugs of the forms shown at *a* and *b*, Fig. 10, are necessary for profitable manufacture of tools and should be kept in drawers in a block or on pins so the edges will not become nicked. More tools are spoiled by careless handling than by actual usage. These plugs and disks may be made as orders come in but the standard sizes up to 2 inches should be at hand to start.

A disk and a plug holder are sketched in Fig. 10 at *c* and *d* respectively. These are made of steel and preferably case-hardened. The disk holder has its shank of a size to fit the standard fly-tool holders, usually made 1 inch square; it also has a slot milled at the back to fit the head of a bolt used and is milled away as shown. The plug holder shown needs no description. The form of plug holder shown at *e* has also been made and used with excellent results. When holder *d* is used the cutting edge of the plug is thrown ahead of the center and consequently is liable to dig into the work when planing. Great care must be exercised when using this and much time may be wasted. Holder *e* allows the tool to spring away from the work instead of into it and so better results are obtained.

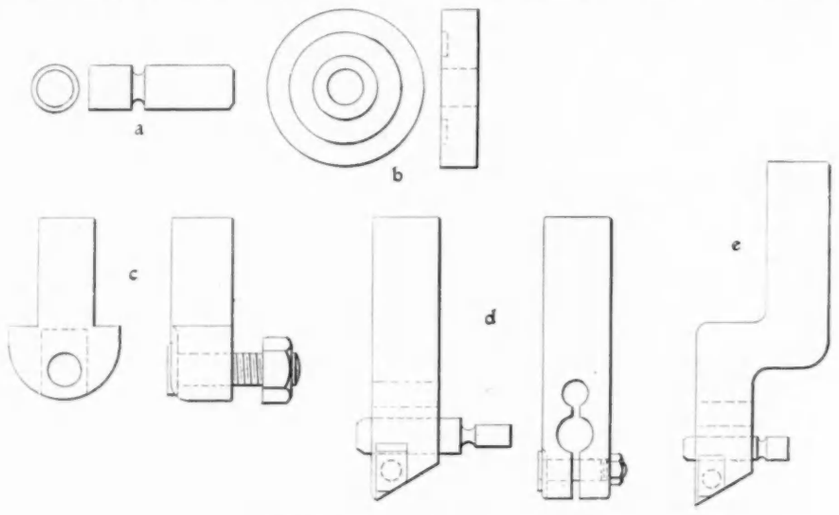


FIG. 10. PLUG AND DISK TOOLS

Gear Cutter Tooth Curves

A method of making formed cutters which costs little for tools and by which very accurate results may be obtained, is used to produce gear cutters for a given number of teeth between the standards, also different tooth outlines from the standard in shops producing a very limited number of cutters.

A thin piece of zinc of convenient size to handle is thoroughly cleaned and polished on one side and a coat of the following solution applied: water 6 ounces, sulphate of copper 1 ounce, and about ⅓ dram of nitric acid. This will blacken the surface of the zinc and should be allowed to dry after which a few drops of oil may be applied and rubbed into the surface with a clean, dry piece of waste. The metal, thus treated, presents an ex-

cellent surface for laying out work and the metal will not damage fine divider points.

The tooth curve is now drawn on the face of this sheet by referring to formulas and tables which produce exact tooth curves. The necessary knowledge and skill required to lay out correct tooth curves is obtained only by deep study, considerable experience, and familiarity with the methods used by experts in this line. The drawings are made by an operator possessing the necessary knowledge and the other operations completed by lower priced labor.

Master Tool Process

After the drawing is completed a master tool is made to fit the curve and is the exact form of one side of a tooth of the gear to be made. It presents the same appearance as *D*, Fig. 6, but the method of working is slightly different.

A piece of stock is roughed out to approximately the same shape as the drawing and carefully placed over the latter in contact with the curved line. The high spots are marked with a lead pencil and filed away from the back. Division lines described as useful for *D*, Fig. 6, are unnecessary and not used in this case as all work is done from the back of the tool. A fly-tool is made by the same method as used for *E*, Fig. 6, except that it is fitted to the drawing instead of to a templet. The formed tools are all finished as before described.

A Truing Fixture

Owing to the fact that errors creep in regardless of all precautions taken it is necessary to true a gear form with one side of the tool before backing off. After the tool is hardened and ground it is clamped in the fixture shown in Fig. 11 which consists of a cast-iron block of the shape shown, having two clamps to hold the tool firmly, two set-screws to adjust the position of the tool, and a bolt to clamp it in the tool-post slot in the lathe. A tongue on the side as shown locates it properly in the lathe and when it is turned on its base on the grinding machine it is in a position square with the center line of the form.

A block of wood is placed on an arbor and one side is turned with one side of the tool properly clamped in the lathe. By reversing the arbor on centers and bringing the form just made in contact with the opposite side of the tool the amount the tool is out of square is readily seen. The tool is then shifted in its holder one-half of this amount in whichever direction it needs to go and another impression made and reversed, this process being repeated until no variation can be detected. The fixture is then taken from the lathe, placed on its side in the grinder and the side of the tool ground.

All tools having the same outlines on each half of the form have to be tested and stoned to produce accurate results.

Cast iron is sometimes used for testing, but this is extremely bad practice as the edge of the tool is quickly worn away and in many cases a tool is condemned or unnecessary work is done on it. Brass or wood are the two best mediums for obtaining an impression. Maple is one of the best woods to use.

Hob-tool Fixture

The results obtained by the use of gear-hobbing machines are bringing these machines into prominence and this means that hobbing cutters are becoming more and more important. The fixture illustrated in Fig. 12 was designed and used very successfully for making these tools. It consists of a base plate *a* with a bolt slot and recess bored to fit a hub on *b*, which is an angle casting planed square on its outside face with the turned face having a hub. A recess and bolt slot are also formed in this piece to fit a hub and bolts of *c*. This part is an iron casting with a hole bored to fit *d*, the hole being parallel to the hub face. After turning *d* to a fit *c* was slotted and a bolt put in to bind *d* when in position. The edges of *b*, *c* and *d* are graduated in degrees.

A tool is placed in the opening *h* and clamped by the set-screws. The part *c* is swung forward to the required clearance angle, anywhere from 22 to 30 degrees, depending upon the angle of thread, and the cylinder *d* swiveled to the required angle of thread. The tool is milled and planed to shape with no other setting

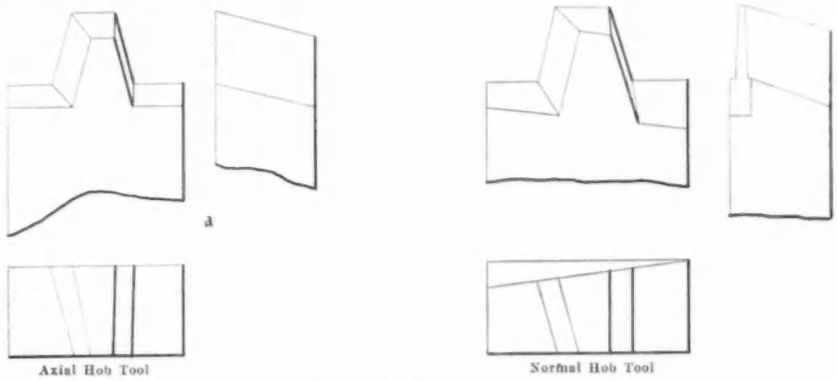


FIG. 13. HOB TOOLS

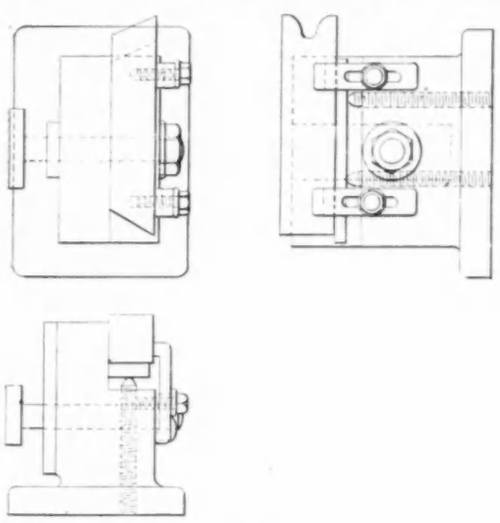


FIG. 11. FIXTURE FOR TRUING AND GRINDING FORMED TOOL

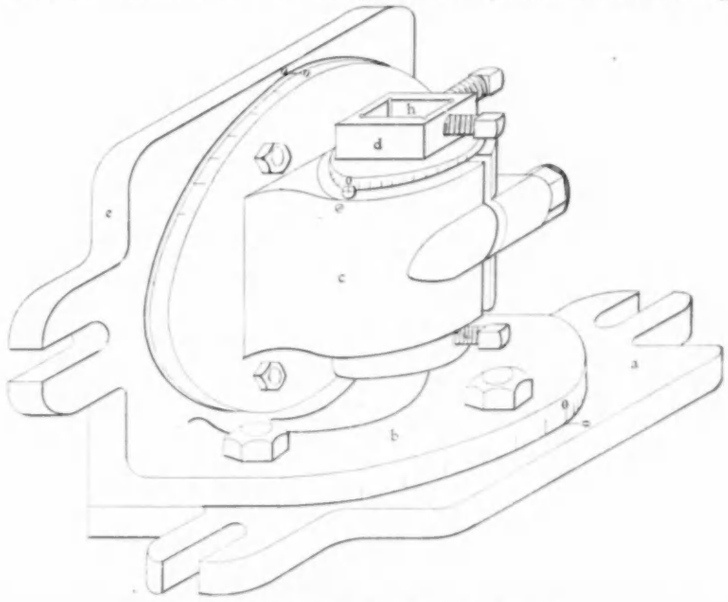


FIG. 12. UNIVERSAL HOB MILLING FIXTURE

ordinarily, but when side clearance is desired, this is obtained by using the graduations on the base of *b*.

Operations on the Tool

The cycle of operations for making a hob tool for gear-generating hobs is about as follows:

A fly-tool is made to a drawing with the proper allowance made for undercut. The stock is clamped in the hob fixture and this turned on the side *c* in the machine with the tool facing the spindle. Cylinder *d* is set at the angle of thread, *b* and *c* are set on zero and the face of the formed tool milled with an end mill. This is done before the other operations to facilitate measuring the tooth parts on the normal plane. The fixture is then turned on the base *a*, c is swiveled to the angle of end clearance. A cutter is put on the machine and the form rough-milled after which it is planed with the prepared formed tool.

By swinging the table platen at an angle to the spindle it is possible and practicable to mill the shape of the tooth nearly to size without a succession of cuts and this saves considerable time. It is also practicable to mill the top and bottom to the exact depth of tooth (by using the cosine figures) and plane the sides of the tool only. When all the cutting surfaces of a tool are planed, great care and considerable time must be used, otherwise, torn surfaces are the result. All surfaces possible should be milled with cutters kept for this purpose.

Forms of Hob Tools

The general forms of hob tools are shown by sketches *a* and *b*, Fig. 13. Tool *a* is made for a worm-gear hob on which the tooth dimensions are figured in a line parallel to the axis of the worm and in the same plane. These tools are usually given side clearance as shown to clear the thread. Tool *b* is made for backing off hobs to cut worm, spur and spiral gears on which the tooth dimensions are figured on a normal, a line perpendicular to the thread, and which is necessarily at an angle with the axis of the worm equal to the angle of thread. Hobs for hobbing spur and helical gears should always be gashed on a normal to the thread.

The Italian state railways have decided to adopt liquid fuel on some of the mountain lines with long tunnels. The special reduction of duty on mineral oils now accorded to Italian state railways will make the cost of working by liquid fuel not prohibitive; and this cost will be still further reduced when it is found convenient to import it by means of special tank steamers. During the fiscal year 1906-7 the cost of coal on Italian railways amounted to 17 cents per train mile, against France's 10 cents.

Trade Opportunities in Argentina

By M. de Moreira

Among all the republics of South America, Argentina deserves our special attention and study. She has gone ahead so rapidly that it is safe to predict that she will have a brilliant future. Her keen rivalry with Brazil, the richest country in South America, makes the struggle for supremacy still more interesting and, at the same time, stimulates industry and commerce. Though essentially an agricultural country there are, nevertheless, many opportunities for the manufacturers of machine tools.

The first thing to do when considering foreign exports, is to study the financial conditions of the country where one wishes to establish his goods. There is no country in South America that can give a better showing than Argentina, whose revenues for the year 1907 were estimated at $94,000,000, whereas the receipts reached the total amount of $105,500,000, or $11,000,000 in excess of the estimate. The bank balances in the republic on December 31, last, showed deposits of $783,000,000 and cash reserves of $311,000,000. The foreign commerce of Argentina for the year 1907 was nearly $600,000,000, a total greater than that of China or Japan, and was composed of imports $285,860,683 and exports $296,204,369. In the distribution of imports the United States takes the third place with $38,842,277; England and Germany come first and second, respectively, and each has an import far superior to ours. This is due to the same reasons which I have ascribed in preceding articles; lack of good traveling representatives, intelligible catalogs, knowledge of the people, banking facilities, etc.

Railway, Highway and Shipbuilding Opportunities

American manufacturers have an excellent opportunity to furnish machine tools for railway shops, as Argentina is literally gridironed with railways. Its lines cover 14,000 miles and have an invested capital of $67,688,876. There is besides 250 miles of secondary lines and roads, and a new line is being built to Bolivia. The English, however, are using all their efforts to obtain the contracts to supply the necessary materials.

It seems to me appropriate to remind the manufacturer who ships his goods to Argentina, to follow minutely the instructions of the buyer as to the size of packages or boxes. The reason for this is that the gage of the railway in Argentina is variable and goods shipped into the interior may go over broad, medium or narrow-gage lines. These 14,000 miles of road belong to 22 companies, out of which 18 have up-to-date repair and building shops requiring machine tools, etc.

Besides going ahead with railways, Argentina is perfecting her highways and bridges. The bureau of bridges and roads of the Argentina republic has $1,500,000 to spend for construction work, out of which nearly a million dollars will go for bridges alone. The chances are that the contracts for the building of these bridges will be given to a native engineer, who has been educated abroad, and a wide-awake American manufacturer can easily, it seems to me, obtain a contract to furnish some of the needed materials and machinery.

Ship building is also increasing. The river La Plata is a very busy water thoroughfare and the commerce between Buenos Ayres and Montevideo is extensive. Many launches, sailing vessels and steamboats are built at the ship-building docks at La Plata. The government dry-dock and repair shops for the navy are up-to-date. The docks in Buenos Ayres are as modern as those of New York, and though the hoisting machinery is nearly all English, still there is a chance for American manufacturers to have theirs used in the new docks.

Activity in rail and water shipping is a sure sign of the industrial progress of a nation. Indeed, the development of industries in Argentina is increasing every year. Sawmills, refrigerating plants, sugar refineries and machinery for mines are shipped from England and Germany.

In regard to mines it must be recognized that the production of minerals throughout the republic is small; however, the Bora deposits and mines at Salta and Jujuy are giving great results. The latter belong to an Anglo-German syndicate that has made large purchases of mining machinery in Europe. Gold, silver, copper, tin and lead are also worked in the southern part of the republic.

Printing Machinery Opportunities

Printing machinery and all the equipment pertaining thereto will find a ready market in Argentina, as the newspaper plants are modern in all their details. The latest statistics that I have been able to obtain show that in one year Argentina has imported printing machinery to the value of $78,388, of which only $7692 came from the United States; the rest was supplied by Germany. American type-setting machines have been successfully introduced but the manufacturers have made no serious efforts to push their sale; apparently they are satisfied to have sold a couple of them. Some rotary presses, manufactured in the United States, have been bought by an Argentina newspaper and given great satisfaction, and I am positive that a good business could be obtained if the manufacturers of that kind of press would send to Argentina a man conversant with the language of the country, who would make some arrangements with an established house in Buenos Ayres to carry them in stock.

A positive proof that the Argentinians are desirous of obtaining the best ma-

chines and machine-tools is, that in September 1907 they passed a law exempting from customs duty during the period of 10 years, machinery, tools and materials necessary for the installation and working of mining and metallurgical establishments which may be erected or which actually exist in the Republic, also machinery, tools and materials for well boring. The only thing, therefore, that the manufacturer has to do is to apply in writing to the custom house through which he desires to effect importation and to pay the charges involved in the verification of the materials.

Our system of steel structures for buildings is being adopted there and in Buenos Ayres an eight story house is being constructed by Americans with materials from the United States; as a rule, however, the steel and the machinery are imported from England, Germany or France.

Great Wealth and Corresponding Opportunities

When one sees the wealth of Argentina, its fine railways, its splendid dock system, its modern buildings, its well equipped factories; when one becomes acquainted with the natives and finds them educated, brilliant, ambitious, desiring to obtain the best each nation can give, one wonders why the American manufacturer does not avail himself of these great opportunities, but lets them slip through his fingers, prefering to endow his foreign competitors with a wealth that could be his.

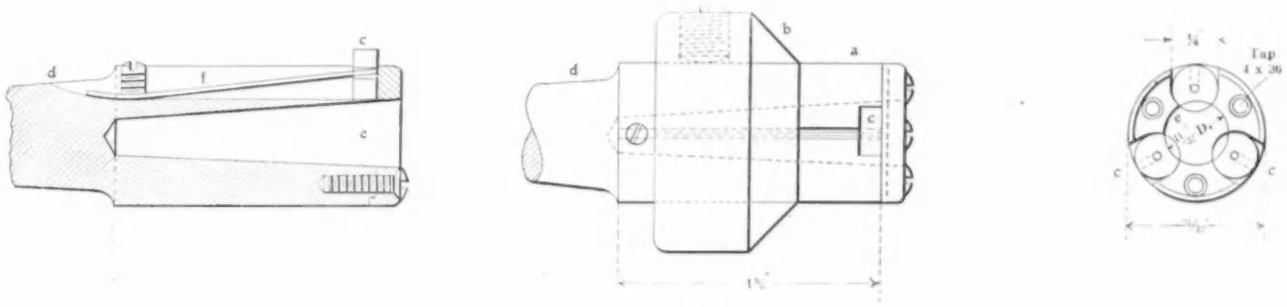
It may be that he does not know that the once solicited long term credits which he was not willing to extend are being done away with and that there is a tendency to purchase direct from him for cash against documents. It may be that banking methods of South American countries which result in loss of valuable time and other disadvantages to the development of the American trade would naturally disappear with the establishment of an American bank; it is, nevertheless, true that this slow development is the result of the North American lack of interest, due partially to the ignorance of the wealth in store for him who will study the South American export question as he should.

A Roll Expander for Brass Rings

By Geo. W. Armstrong

Having to design a series of tools to expand narrow brass rings within iron castings which were previously assembled and which presented an opening quite a little smaller than the inside diameter of the brass rings, I made them as shown herewith, the figures giving the dimensions of the smallest size. The diameter of the brass rings varied from 13/16 to 3 inches for eight sizes while the width ranged from 1/8 to 1/2 inch.

The assembled castings containing the brass rings to be expanded were placed over the expander body *a* and against the beveled collar *b*, which located the rings over rolls *c* and centered the end of the hole in the casting on the bevel. The



A RING EXPANDER

castings were held by hand from rotating with the expander whose shank *d* fitted the drill lathe.

The lever on the tailstock introduced a taper pin into the hole *e*, and forced out the rolls against the brass rings, expanding them into their seats; the taper pin being free to rotate in the tailstock spindle. The rolls were returned and retained by piano-wire spring *f* held in the bottom of the slots as shown.

The end view shows the cap removed. The largest two or three expanders in the set were made to screw directly onto the nose of the spindle.

The Gisholt Club

There is no question as to the advantages of harmony among the employees of any plant and a club of this kind, when it is spontaneous and managed by the employees themselves, is a great help in this direction. The Gisholt Club has been in existence for several years, a room having been provided by the Gisholt Machine Company, Madison, Wis., and its main object is the promotion of good fellowship. They now have a band which dispenses music at the various entertainments, picnics, etc., and gives open-air concerts near the works.

Forging Chain Hoist and Crane Hooks

By S. L. Reginald

Having large quantities of chain hoist and crane hooks to forge, as shown in Fig. 1, and not possessing a drop, we soon found the ordinary method of forging them on the anvil far too slow and expensive, consequently other means had to be devised to facilitate rapid production. To those unacquainted with the process of hook forging, I would like to point out that the greatest care is required, and it is a very difficult operation to produce a good reliable hook.

With the tackle here shown, many thousands of hooks have been forged in a very satisfactory manner.

The first operation on the 1- and 2-ton size, is to take a bar of the required diameter, about 6 feet long and taper the point (as shown at Fig. 2) under the steam hammer with the spring swages, shown at Figs. 3 and 4. After a batch has been similarly treated, they are again reheated and bent to the shape shown in Fig. 2, *A*, by the aid of the fixture shown in Fig. 5, also in plan at Fig. 6. This is a square steel block, with a spigot on the bottom, which drops in the square hole provided in all anvils. *A* is a steel stud let into the block which is the same diameter as the radius *D*, in Fig. 1. *B* is a smaller stud to get the correct shape of hook. The pointed bar is shoved between *A* and *B* (as shown dotted in Fig. 6) the bending lever, shown in Figs. 7 and 8, is then brought into operation, the hole *E* being bored to fit on *C*. *H* is a slot hole which carries a steel roller *F*, which fits on the stud *G*, adjustable in the slot hole and secured in position by the nut *I*.

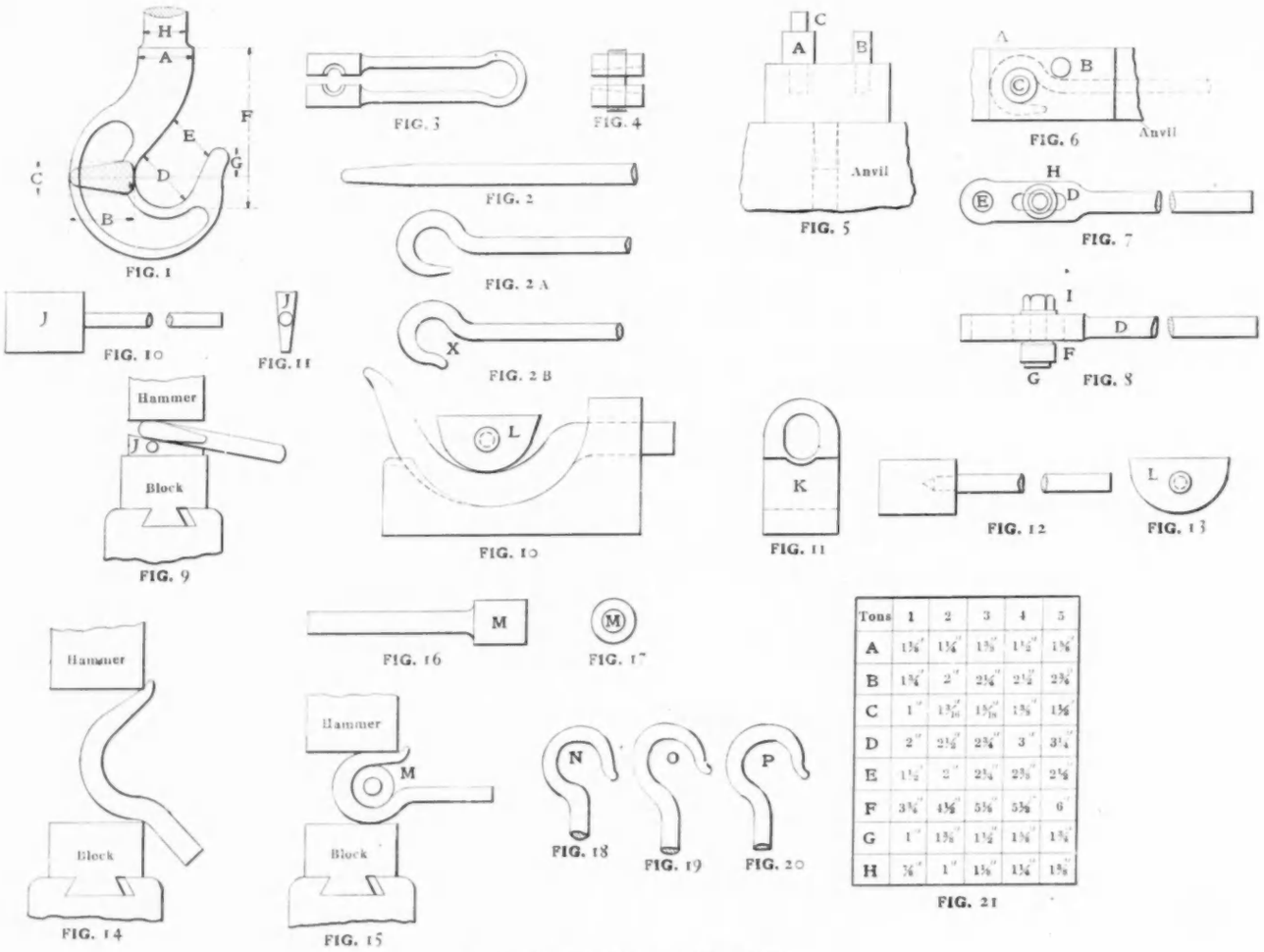
The helper takes the end of the lever *D*, and, with the roller at the back of the bar, walks round the end of the anvil and bends the hook quickly to the shape shown while still hot; the smith gives the hook two sharp blows on the inside of the point *X* (one on each side), the hook then appears as shown in Fig. 2, *B*.

The third operation is to hammer the fish back on the hook to prevent it from opening when overloaded. Hooks up to 2-ton size will not require reheating for

this operation, the previous operation only taking a very short time. Fig. 9 shows the hook in position under the steam hammer for the third operation; it is simply laid in the correct position on the tapering block *J*, which has a long handle screwed in the end, as shown in Figs. 10 and 11. For the last operation, the hook will have to be reheated and gaged for size with a flat steel templet. Should it have been slightly distorted under the steam hammer, which is quite probable, it can be tapped to the correct shape with a hand hammer, and the shank cut to the correct length on the anvil with a sledge

the steam hammer. It has a slightly elongated hole drifted through the end (as shown in Fig. 11) through which the pointed hook is passed. The radiusing block *L* (also shown in Figs. 12 and 13) is put on the top and the hook is hammered down to the shape shown, the bottom of the block being made a suitable radius. The hook is then taken out and reheated and put on the hammer block in the position shown in Fig. 14, the hammer is brought down onto the point of the hook gently, and steam admitted into the cylinder, until it is bent to the position shown in Fig. 15. *M* is a round steel

fully handled, and ought not to be put into use, as a load would probably slip to the outside corner and have a tendency to open the hook. Fig. 19 is another common fault which arises when forging hooks, the part *o* being the highest. This hook is much stronger than Fig. 18, but if used on a chain hoist, the block, when loaded, would not hang exactly perpendicular. The tendency to open this hook, however, is not so great as either Fig. 18 or 20. Fig. 20 is perhaps the most seriously defective, and also most easily produced. The part marked *P* is the highest. This is caused by the hook bending more



Tons	1	2	3	4	5
A	1⅜″	1¼″	1⅝″	1½″	1⅝″
B	1¾″	2″	2¼″	2½″	2⅞″
C	1″	1 3/16″	1 5/16″	1⅜″	1⅝″
D	2″	2½″	2¾″	3″	3¼″
E	1½″	2″	2¾″	2⅞″	2⅝″
F	3⅜″	4⅛″	5⅛″	5⅝″	6″
G	1″	1⅜″	1½″	1⅝″	1¾″
H	⅞″	1″	1⅛″	1¼″	1⅜″

FIG. 21

TOOLS FOR FORGING CRANE HOOKS

hammer and cold set. The hook is then ready for its final inspection before being turned on the shank.

Hooks of 3 tons capacity and upward, are more difficult to forge, due to the increased thickness of the material used in their construction. They are first of all cut off in straight lengths under the steam hammer cold, as long bars are too heavy to handle quickly. The next operation is to point them as in Fig. 2, with the spring swages shown in Figs. 3 and 4. The bending fixture, shown in Figs. 5 to 8, cannot be used for the larger sizes, as it would take two or three men to pull the lever round, so we devised the block *K*, shown in Figs. 10 and 11, and used on

mandrel of the correct diameter to bend the hook to, which will now probably require considerable skill on the part of the smith to adjust it to the correct size. The next and last operation is to forge the fish back on the hook, exactly as shown in Fig. 9, with the same tackle.

Hooks properly forged should hang exactly central with the shank when suspended with a load on, otherwise they are defective. Figs. 18, 19 and 20 show defective forged hooks, which are often unnoticed by the smith when finished, but are an eyesore when hung up, and not fit to be used. Fig. 18 is flat on the inside, as shown at *N*. Hooks very easily assume this shape when being forged, if not carefully at that part than further back, due to the material commencing to taper away for the point, the load would always hang on the point *P*, and have a great tendency to open the hook. This is a very dangerous shape and should be condemned and sent back to the smith for correction.

These hooks should be made of a good quality of wrought iron. It is not so brittle as mild steel, and generally gives more warning when overloaded by slowly opening out, whereas steel sometimes snaps off suddenly without much warning. Fig. 21 shows a table of the leading dimensions of hand-crane and chain-hoist hooks of from one to five tons capacity

A Measuring Machine of Simple Construction

A Work Gaging Machine with Sliding Contact Plunger and Multiplying Levers for Moving the Indicator Pointer over a Graduated Arc

BY OSCAR E. PERRIGO

A measuring machine of simple design and construction was desired, and this was designed more particularly with a view to its use as a limit measuring machine, although by the use of inside measuring rods supplied with micrometer mechanism for adjusting the measuring head, it could be used for measuring purposes similar to more expensive machines.

In the engravings Fig. 1 is a front elevation; Fig. 2 a front end elevation; Fig. 3 a rear end elevation; Fig. 4 a plan and Fig. 5 a vertical section of the measuring mechanism; Fig. 6 is an enlarged section of the operating or measuring plunger.

Like most of its class the bed *A* is of rectangular, box-like form, and is 3½ inches wide, 4½ inches deep, and 18 inches long, although it may be made considerably longer by adding, say ¼ inch in depth for each 4 inches added in length, up to 28 or 30 inches. The thickness of the casting is uniformly ⅝ inch, and the side members are tied by the two ends and two cross bars equally spaced along its length. Both the top and bottom members are slotted, the former to receive the holding-down bolts of the measuring head and the footstock, and the latter for the purpose of equalizing the amount of metal and the consequent strains as much as possible.

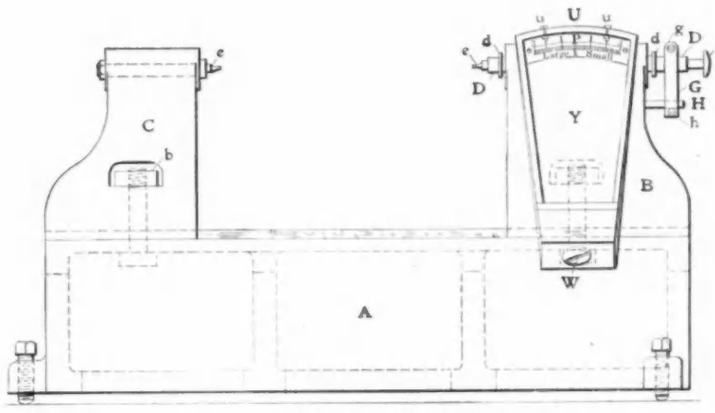


FIG. 1. Front Elevation.

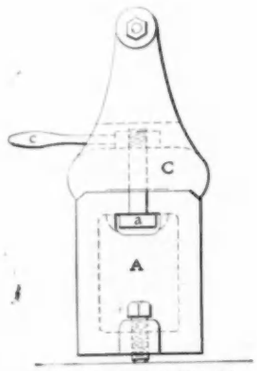


FIG. 2. Front End Elevation.

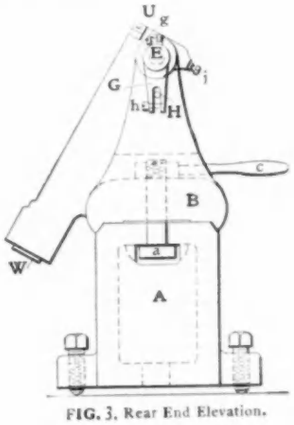


FIG. 3. Rear End Elevation.

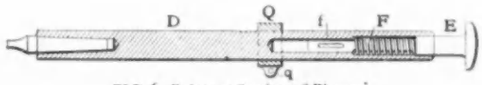


FIG. 6. Enlarged Section of Plunger.

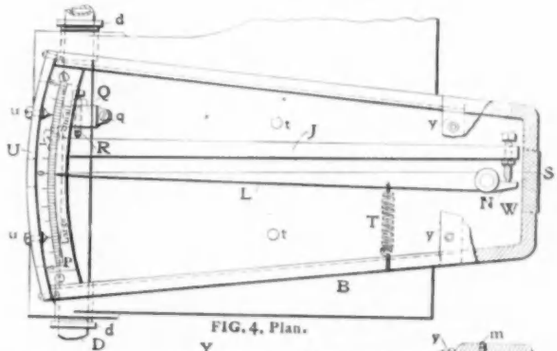


FIG. 4. Plan.

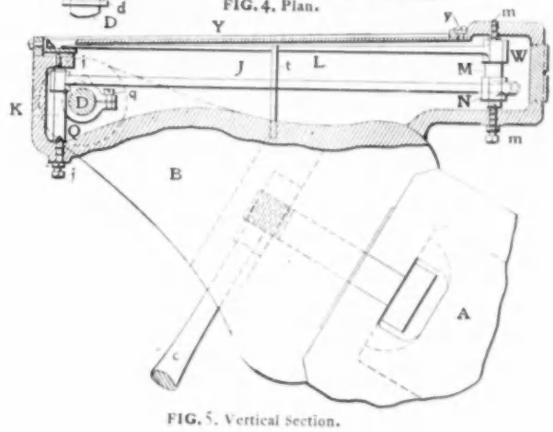


FIG. 5. Vertical Section.

SIMPLE MEASURING MACHINE

The Bed, Head and Footstocks

The bed is supported at three points on leveling screws tapped through lugs cast upon its lower edge, two of these being at the right- and one at the left-hand end, as the machine is arranged contrary to the usual custom, with the measuring head at the right-hand end. This disposition is made for the purpose of convenient operation, as the piece of work to be measured is more conveniently held in the left hand, while the measuring plunger is operated with the right.

The measuring head *B* and the footstock *C* are fitted to V-shaped surfaces of 45 degrees at the upper corners of the bed in the same manner as the headstock and tailstock of a watch lathe. These are each adjustably clamped to the bed by means of the bolts *a a* and nuts *b*, which latter are operated by the levers *c*.

The footstock *C* has a bearing of 4½ inches on the bed, and a vertical hight of 4½ inches to the center of the spindle. The spindle is ⅜ inch diameter, enlarged at the front end to 9/16 inch, bored and reamed for a taper center, as shown in Fig. 6. It is fitted tightly in the casting and secured by a nut on the outer end. The centers *e e* are of the form shown, the end coming in contact with the work to be measured being usually 0.10 inch or less diameter and very carefully lapped to exact right angles to the center line. These centers are made with various forms and diameters of contact points to conform to the differing forms of the pieces to be measured.

The Measuring Plunger

The measuring plunger *D* is ⅜ inch diameter and fitted into two split bushings *d d*, which are tapered and threaded on the outside and fitted to tapped taper holes in the casting. The front end of the plunger *D* is drilled and taper reamed for the center *c*, and its rear end drilled and reamed for the reception of the secondary or thumb plunger *E*, which is an easy sliding fit and is forced outward by the helical spring *F*, and limited in its travel by the pin *f*, in a slot through its smaller diameter, as shown in Fig. 6. Upon its rear end is formed a thumb flange for convenience of operation. Near the rear end of the plunger *D* is a clamp arm *G*, fixed in its proper position by a clamp screw *g*, and having its lower end slotted to embrace the guide pin *H*, fixed in the casting *B*. The arm *G* is adjusted to a sliding contact by the screw *h*, Figs. 1 and 3.

The Internal Mechanism

The measuring mechanism is shown in Figs. 4 and 5. The casing containing this mechanism is cast integral with the casting of the head *B*. The mechanism is designed in as simple a manner and of as few parts as possible. It consists essentially of a primary and a secondary lever of suitable lengths and properly supported and pivoted, the primary lever being acted upon by the measuring plunger and communicating motion to the secondary lever, which is also the pointer or index whose point, passing over a graduated scale in the form of an arc, gives the required readings.

The primary lever *J* is fixed upon the shaft *K*, which is supported upon the pivot screws *j j*, the upper one being tapped very tightly in the supporting lug, and the lower one being adjustable, and secured by a check nut. The secondary lever *L* is similarly mounted on shaft *M*, and supported upon pivot screws *m m*. Upon shaft *M* is also fixed the short arm *N*, which acts as a short arm of the lever *L*, whose opposite end is pointed and travels over the graduated arc *P*, fixed to the casing by two screws. The length of the long arm of each of these levers is 6 inches, and the length of the short arms is 0.30 inch, giving an individual ratio of 1 to 20, and a combined multiplying movement of 400 to 1. Hence, the graduations to thousandths of an inch, numbered on the scale 1, 2, 3, are quite coarse, and the finer graduations representing tenths of thousandths are easily read.

Lever Contact Screws

Upon the measuring plunger *D* is placed the clamp ring *Q*, fixed in the desired position by the clamp screw *q*, and having tapped through a suitable projection the pressure screw *R*, secured by a check nut, and its point bearing against the side of the lever *J*. In the end of the long arm of this lever is a similar screw *S*, the point of which bears against the short arm *N*. These pressure screws have hardened and ground, 60-degree V-points whose apex is very slightly rounded. The levers *J L* are held in their proper places, with the screws *R S* in contact, by the helical spring *T*, and confined within suitable limits of movement by the pins *t t*, fixed in the casing.

These operative parts are covered and protected by a plate *V*, sliding in suitable slots in the casing and secured by the screws *y y*. The screw plug *W* gives access to these parts from the lower end of the casing. When once properly adjusted the screws *R S* do not need to be changed for a long period of time.

The Limit Points

Immediately outside of the graduated arc or scale *P* is the flat curved steel bar *U*, having formed in it two slots in which are placed the pointers *u u*, whose shanks are threaded and provided with nuts by which they may be secured at any desired point. The purpose of these points is to indicate distinctly the allowable limits within which the piece of work being measured must come to be acceptable, rather than to make these limits the subject of oral instruction which might be forgotten, unheeded or carelessly maintained.

In designing this machine, the fact that the points of the pressure or contact screw *S* move in the arc of a circle, and that the surface with which the screws *R S* come in contact are radial lines swinging from a pivot point with a comparatively small radius in the case of the short arm *N*, was duly taken into consideration as affecting the accuracy of the resulting measurements. But as the angle of movement on each side of the center line of the lever *J* is hardly appreciable, and that of the lever *L* is less than 11 degrees, the variation of the arc thus described from a straight line, even in the short arm *N* is so very slight as to make no perceptible difference. If extreme accuracy were required on a scale whose graduations were of considerable length, these slight variations could be compensated for by the proper variations in the graduations, determined by tests with a measuring rod provided with a micrometer mechanism.

Operation of the Machine

In the operation of this machine centers are provided according to the form of the piece to be measured, and proper supports used when the dimensions and the form of the piece require it. A perfect or model piece, or an inside calipering rod provided with a micrometer head, and set to the exact dimension required, is placed against the center of the footstock and the measuring head moved up to such a position that when the measuring plunger is pressed forward with the center in contact with the rod or piece, the index pointer *L* will stand at zero. The measuring head is then clamped to the bed in this position. The limit points *u u* are then set at the prescribed limits, large and small, and secured.

In adjusting the measuring head it was thought that there should be on the bed at its right a block, readily clamped in any position along the bed, and carrying a longitudinal screw whose point would come in contact with the measuring head, and by means of which a fine adjustment could be easily made. However, in practice this was soon discarded and the head was properly and quickly adjusted by light taps with a hammer.

In operating the machine pressure is applied to the thumb plunger *E* in pressing the measuring center in contact with the piece of work to be measured. Any excessive pressure is relieved by the helical spring *F*, so that the accuracy of the machine is not affected by varying pressures.

Speed of Operation

When used as an inspecting machine for limit measurements it may be operated very rapidly, even by a comparatively inexperienced operator, and pieces measured at a rate of thirty to forty per minute. The pieces are usually divided into three lots, namely, those passed as correct, those rejected as of no further use, and those which may be made serviceable by some slight additional operation. As the *extent* of the fault in dimension of the piece, as well as the *fact* of its faulty machining is at once shown, many pieces can be saved by a slight change, which might be lost if they were tested with solid gages of fixed limits showing only the fact that the piece was good, or was defective.

The new Australian tariff law will contain a provision imposing a tax of £5 ($24.33) on every unproved gun barrel entering that Commonwealth. American firearm manufacturers, who now have an annual trade of about $200,000 in Australia, have the proper facilities in this country for complying with the regulation, which requires that gun barrels shall have been "proof-tested" in order to avoid the £5 duty charge. The arrangement in the United States for proving gun barrels intended for export was devised by the Bureau of Ordnance of the War Department five or six years ago at the Springfield Arsenal, and the order is still in effect. This will enable the American manufacturers of firearms to comply with the Australian law at a comparatively small expense.

Wind-pressure experiments conducted by Mr. Eiffel have led him to the conclusion that the resistance offered by the air to a moving surface is practically proportional to the square of the velocity, that is, for velocities of from 60 feet to 130 feet per second, which was the extent to which his experiments went.

Practical Letters from Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

A Peculiar Case of Wear in Gear Teeth

Some seven months ago we installed in our works a specially high-grade marine boiler shell-drilling machine, having two drilling heads working on one bed. From the first a slight knock was noticed when one of the drilling heads was at work, but the cause was not discovered until a week or two ago. At that time the noise became so excessive that a thorough investigation was made and the trouble was located in the miter drive between the horizontal driving shaft and the vertical spindle. As is usual with such wheels they were difficult of access. When observed they were running absolutely true, but on one side of the wheels the teeth gearing together were worn almost to a knife edge and, of course, badly hammered, while those on the opposite side were quite unworn. They appeared to be properly in gear.

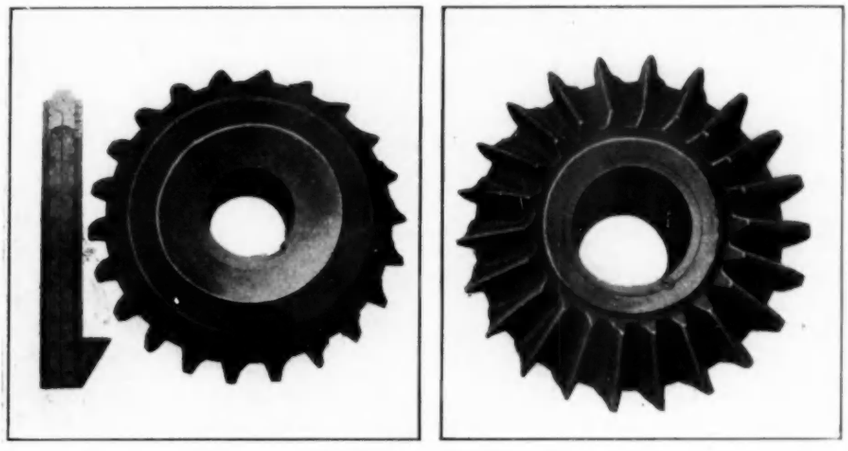
When approached on the matter the makers maintained that the wear must be entirely due to lack of lubrication of the teeth, and though this may be true, I do not feel wholly satisfied with the explanation. Do any of your readers know of a similar case or can anyone suggest a cause?

The duplicate pair of miters in the other head are working well.

The shafts make 380 revolutions per minute; the wheels are wrought steel about 9⅝ pitch diameter with 22 machine-cut teeth. The photographs reproduced will give a clear idea of the appearance of the wheels. The marks seen on the back of the one wheel were produced when removing it from the shaft.

E. FERGUS DUNCAN.

Glasgow, Scotland.



A PECULIAR CASE OF WEAR

Rack Cutting on the Lathe

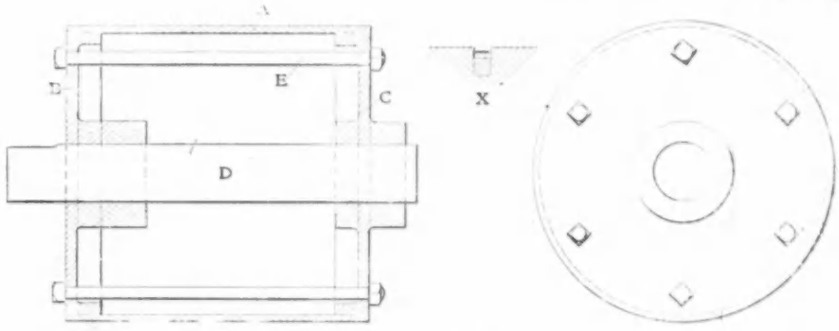
Some time ago I was shown a device used in making a quantity of steel racks, 28 pitch, 3/16-inch face and 12 inches long. It struck me as having some merit in point of cost and rapidity as well as in proof of the fact that there is such a thing as "good enough" in manufacturing where cost is an object.

The racks were used in some sort of computing machine, being set into grooves in a cast-iron plate as illustrated at *X*.

The device consisted of a mandrel *D* which carried two heads *B* and *C*. *B* was driven on tight while *C* was a good snug fit but could be removed without driving. The heads were turned on the outside edge to about 12 1/16 inches with a dovetail shoulder as indicated.

A piece of 12-inch steel pipe was chucked in a lathe and bored on each end to fit the heads. The whole was then assembled on the mandrel, the bolts *E* drawn up snugly and *C* secured to the shaft by a set-screw. The whole was then placed between the centers of a lathe and turned on the outside to about 12 9/16 inches diameter.

A thread was cut on the pipe with a lead equal to 28 diametral pitch. New gears were made for this purpose, the two with the device being 35 and 52 teeth and calling for a lead screw of 6 threads per inch or its equivalent.



RIG FOR TURNING RACKS

In cutting the thread a forged tool was used for roughing with the compound rest set at right angles to the cross-feed. In this way a cut could be taken from the bottom of the space or from the side without any tendency to tear. The thread was cut to the full depth but a very little was left on the sides for finishing.

The finishing cut was taken with a 28-pitch rack cutter bolted to the side of a parallel which was clamped to the cross-slide, the tool post being removed. One tooth was removed from the cutter the better to see how the tool was cutting and to give more room for stoning the cutting edge.

When the thread was properly finished the whole was removed to the milling machine where it was placed between the centers and the dividing head set for 152 divisions. A 1/16-inch saw was used in cutting the racks apart, which left a strip a very little under size at the back and a little over size at the face of the rack.

In removing the burs from the sides of the teeth with a file the difference in dimensions above referred to was considerably decreased.

The backs were then milled parallel

with the face and the racks were finished.

No difficulty was experienced in parting the racks until near the last, and this was overcome by not cutting clear through on the last few cuts; these racks were afterward separated with a hack saw and required milling on the side.

The curvature of the face and angle of the teeth were so slight as to be scarcely noticeable for a width of 3/16 inch and where this error is allowable the saving in time and cost over ordinary methods was enough to make it an object.

Marquette, Mich. E. C. O.

An Indexing Attachment for the Hand Miller

Among our manufacturing problems was that of producing a number of small tool-steel ratchet wheels whose working faces varied in width from 5/16 to 7/16 inch, and whose diameter extremes were from 7/16 to 13/16 inch. They were also in many cases required to be conical, the angles varying in increments of 5 degrees from parallel to 40 degrees included angle. The holes in them were either 5/16 inch or 3/16 inch and were counterbored. These variations occurred in lots of from 50 to 100 and consequently while being somewhat of nuisance, were not a serious bar to economical production.

When we first started to make them we had a No. 2 universal miller tied up on the job most of the time, and as this represented an investment of somewhere near $1000, we naturally wanted to get from under the load; the more so as it took a pretty good operator to produce them satisfactorily; we bought a standard bench hand miller and made the index head, shown in Fig. 1, which represents the general arrangement of the device with the axis of the spindle parallel to the plane of the platen.

Fig. 2 shows a cross-section through the cylindrical block *A* which carries the spindle *B* freely mounted in a parallel bronze bush. A bolt *C* provides a means of clamping it at any desired angle to the angle plate *D*, which is graduated to facilitate setting. On the extension of the spindle *B* at the rear of the head is mounted the 59-tooth ratchet wheel *E*, Figs. 3 and 4, which is inclosed in the oscillating pawl casing *F*, which is provided with six equally spaced pawls *G*. A sleeve forming part of the ratchet wheel *E* provides a place to mount index plate *H*, secured by screw *I*, Fig. 4, which bears on a flat spot. This detail could be improved upon.

The pawls *G* are made of square drill-rod hardened and ground, and are spring-depressed, as indicated in Figs. 3, 4 and 5. A small roller *J*, mounted on a pin in the pawl casing *F* engages with finger *K*, which is secured, as shown in Fig. 1, to the oscillating cam plate *L*.

An angularly adjustable lever *M* is secured to the hub of the oscillating plate *L*, and is arranged to engage with the screw *N*. A screw (not shown) secured to the cross-slide and passing through a lug in the end of the platen, together with two pairs of locking nuts furnishes a commonly used stroke-limiting device. It may now be observed that on bringing the platen back in the direction of the arrow, the lever *M* engages with the screw *N*, thereby causing the cam plate *L* to revolve, allowing the roll on the lock lever *O* to fall into the depression on the periphery of the plate and allowing the index plate lock *P* to disengage by means of the spring *Q*, Fig. 1.

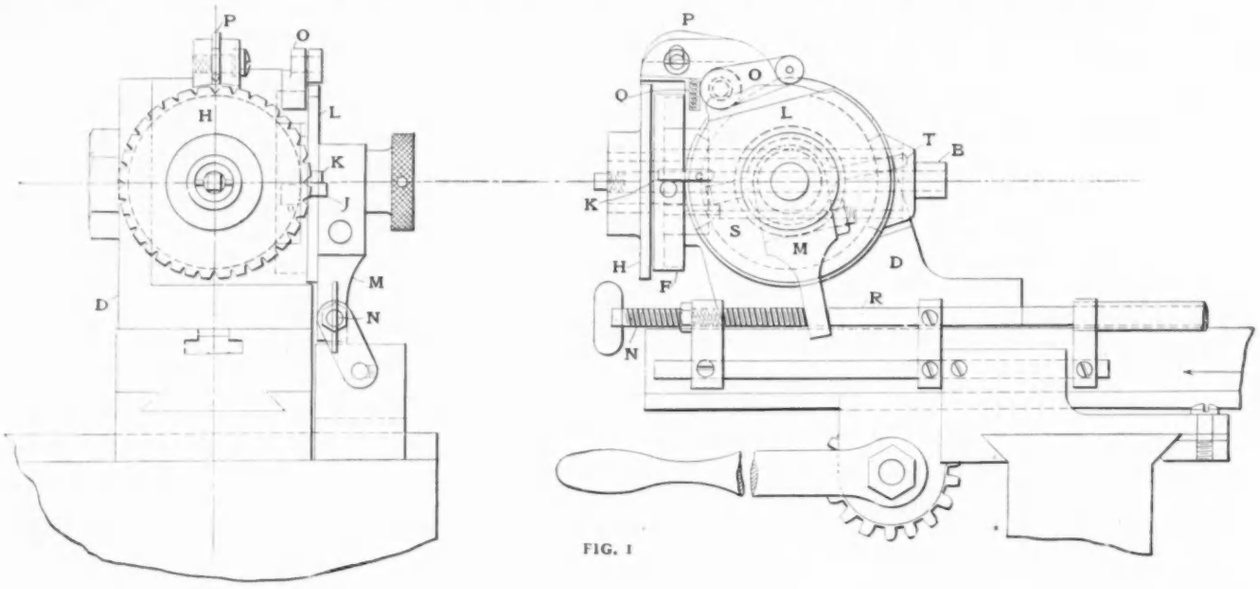


FIG. 1

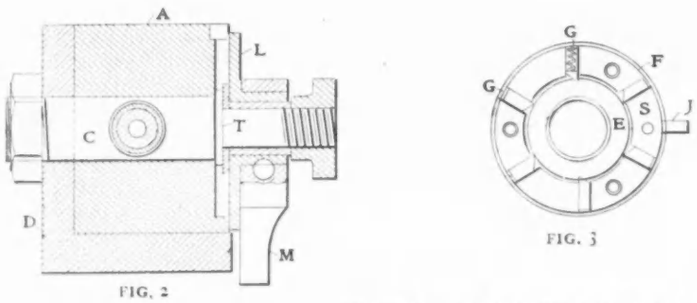


FIG. 2

FIG. 3

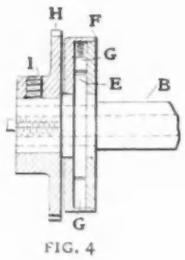


FIG. 4

FIG. 5

INDEXING ATTACHMENT FOR HAND MILLER

A further movement of the plate *L* brings the finger *K* into engagement with the roller on the pawl casing *F* which is revolved, carrying the index plate and spindle with it until the stop is reached. The direction of the platen is now reversed bringing the telescopic spring pressed rod *R* into action, which serves to revolve the cam plate *L* in the opposite direction, allowing the pawl casing to re-

cover its position by means of a circularly disposed helical spring in a recess in the block *A*. The motion of the pawl casing is arrested at the proper point by the pin *S*, Figs. 1 and 3, which projects from its inner side, becoming engaged with the end of the adjustable lever *T*. A further motion of the platen revolves the cam plate *L* until the roller rises again, thus locking the index plate in its adjusted position until the cut is completed. The adjustments necessary for a change in the number of teeth to be indexed are quite obvious, and I may add, are easily manipulated by the boy who runs the machine.

The machine was at first made full automatic, but we found that, in view of the fact that the changing of the pieces called for constant attention on the part of the operator, we attained higher efficiency by letting him do the feeding himself.

The arrangement of the 59-tooth ratchet in combination with the six equally spaced pawls gives us the equivalent of a 354-toothed ratchet, which allows us to make a close enough approximation to any division we are likely to need, with the assurance that the lock will correct the error.

Rochester, N. Y. L. W. G. FLYNT.

Laps and Lapping—RotaryLaps

I wonder sometimes why we do not see more printed matter on laps and lapping, especially on rotary laps, their construction and how to charge them. Some time ago I spoke to a very competent toolmaker who was a fellow-workman in the toolroom, in regard to this matter and when I mentioned a rotary lap he wouldn't believe that accurate work could be done on it, and also stated that he hadn't seen any in use and had been employed in some of the best shops of the country. He had a knife-edge square, Fig. 1, that he had lapped on a hand-lap and I had one that I lapped on a rotary lap and we found that one was as accurate as the other.

In a small shop where I learned how to use laps, we had a rotary and a hand-lap; the rotary was 24 inches in diameter, and the speed about 300 revolutions per minute. The hand-lap was about 18x20 inches. Fig. 2 will give a clear idea as to the make-up of the rotary lap. I have found that some men who have used laps have an idea that they should be made with grooves and checks, which I think

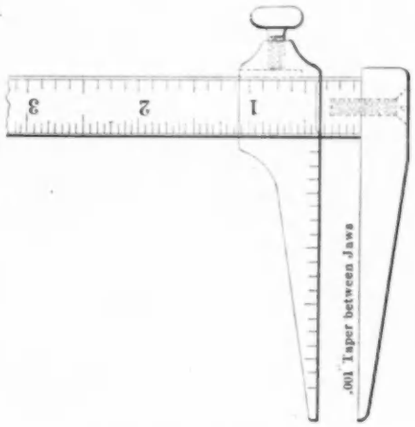


FIG. 4. HANDY CALIPER GAGE

are fallacies, for I have proved to my own satisfaction that they are not essential to keep them from filling with "birds' eyes." Again I have noticed that some men think that if the lap has a true, flat surface anyone can produce true work, but not so. It requires considerable skill and that skill can be acquired only by "trying it yourself." Many machine operations can be shown to another and the principle grasped readily, but it is not so with this class of work. I know that many were the occasions when I had the foreman show me how he did the lapping and yet, when I went at it, I could tell that there was something that I had to feel and experience for myself, as the boss used to say, "you must get in touch with your work."

A great deal of skill is required in lapping thin pieces, small, straight edges or long, narrow strips. It is possible and requires no skill at all to lap a piece of steel convex or concave by using a little more pressure in one place than another, and if the surface of the lap is not kept sharp it will soon heat and peen the work out of true. For a lubricant, I have found that kerosene and gasolene used together give the best results and the hand-lap should always be used dry. Keeping the surface of the lap straight and true is very important and good judgment is required in using it. The outer edge of the rotary lap runs so much faster than the inside, it is obvious that if it was used too much, either in the middle, inside, or outside, hollow places would be worn in the surface, so it is a good plan to use it all over and try the surface frequently with a straight-edge.

The rotary lap is charged by sprinkling carborundum over the surface when not in motion and then pressing it in by rubbing with a piece of round iron held in both hands. An old pepper box with a perforated top is just the thing to use for sprinkling the carborundum.

The lap I have used is made of an ordinary cast-iron disk with ribs on the bottom and anchor grooves on the top; it is also provided with a hub and a shaft. The end of the shaft supports the whole weight and runs on a hardened convex disk. A coating of lead is cast over the surface and then hammered to make it compact. A galvanized-iron pan is provided, the edges of which project

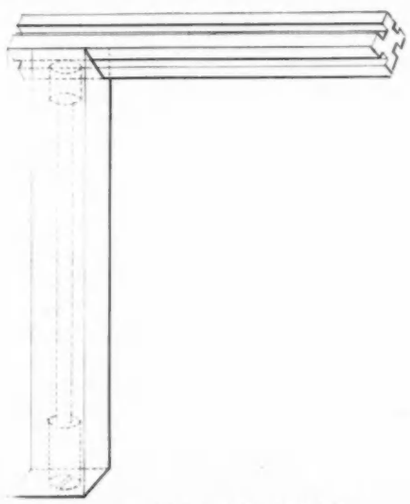


FIG. 1. KNIFE-EDGE SQUARE

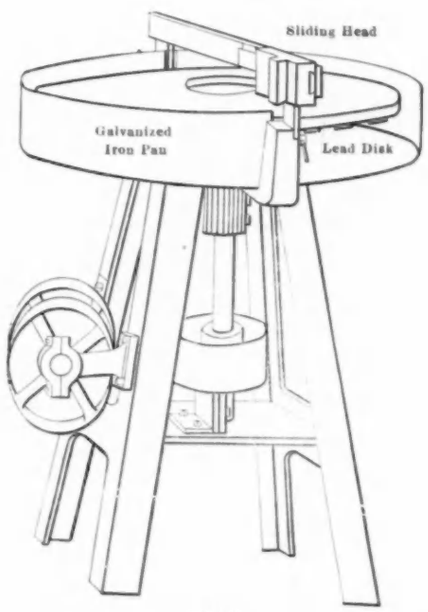


FIG. 2

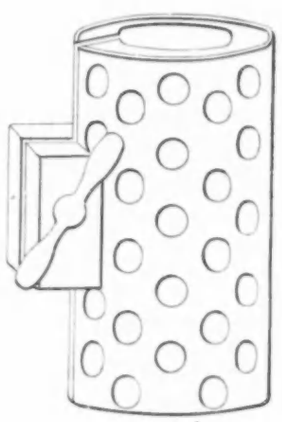


FIG. 3

ROTARY AND HAND-LAPS

above the surface of the lap to prevent the liquid or whatever is used from flying off and onto everything around. Another handy device on this lap is a bar which is provided with ways and a sliding head which can be pushed from the outer edge to the center of the lap. The bar is fastened to lugs which project on opposite sides of the frame and can readily be removed when not in use; it also has adjusting screws to level it parallel with the surface of the lap or to set the sliding head square with the surface. The sliding head has a square corner and an angle groove which can be used when lapping the ends of round or square pieces. Keep the lap sharp and true and it will be found a mighty useful machine to have in any toolroom; on accurate work it will always show up the imperfections of the surface grinder, and besides, it gives a polished surface to the work.

Sometimes an apprentice, such as I was once upon a time, will wear the surface of the lap so badly out of true that a cut must be taken across the face to straighten it. I proceeded by belting the lap to the slowest speed on the drill press, then I clamped a piece of self-hardening steel on the sliding head and by means of a ¼-inch threaded rod fastened in an eye on the sliding head and working through a stationary nut fastened on the frame of the machine, I was able to take a cut across the surface and get the face back in shape again.

The sketch, Fig. 3, shows how I usually make a lap for outside work, to be used in the lathe. A piece of wrought-iron pipe with a number of holes drilled through, will answer the purpose. Face one end of the pipe so that it will stand level on a surface plate, wrap a piece of heavy paper around the outside, using rubber bands to hold it on, then form a square with pasteboard and clamp that on one side of the pipe so that several holes open into the square; use a mandrel near the size of the piece to be lapped, twist a piece of string in a spiral around the mandrel, insert it in the center of the pipe, and we are ready to pour the molten lead in. When cool, drive out the mandrel and proceed to drill and tap a hole for a thumb-screw in the center of the lug, then slit one side of the whole thing through the center of the lug with a hack-saw, and file off all sharp edges and burs so as not to injure the hands when being used. In lapping, the faster the lap is drawn back and forth over the work the more perfectly straight will be the results, and as the lap wears and works easily, give the thumb-screw a slight turn and keep it in contact with the work. In using flour of emery, I find that by putting a small quantity in a bottle half full of machine oil, I can get the coarsest emery by dipping a swab down to the bottom or finer by shaking a little and using the oil only for finishing. The coarser particles sink to the bottom while the finer particles are held in suspension in the oil.

Taper lapping is very difficult and requires patience, but it is a possible task. The cast-iron lap must be constantly trimmed, kept straight, and to the same taper as that desired in the piece being lapped. It must also be kept well lubricated and not crowded.

The handy tool shown in Fig. 4 is almost indispensable in doing work on rotary and hand-laps. It is a home-made caliper square. The hardened jaws are tapered 0.001 inch in the whole length and a 6-inch flexible scale is inserted in the beam. This caliper is not used so much for accurate measurements, but is used for accurate gaging for parallelism or in duplicating sizes.

Always consider temperature when measuring lapped work.

Minneapolis, Minn. A. J. DeLille.

How to Tighten a Bushing and Harden a Cylinder

About six years ago our firm received a telegram from the dean of one of the leading engineering colleges saying that the hydraulic testing machine was out of kilter and to send a man down immediately. I happened to be the unfortunate sent.

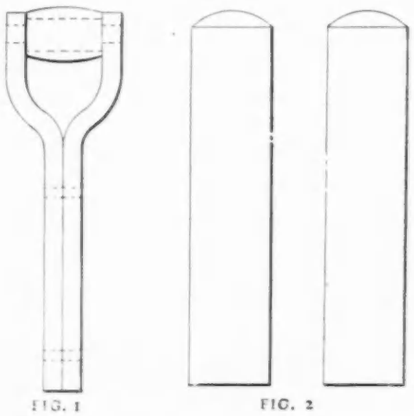


FIG. 1 FIG. 2

THE TOOLS USED

When I presented my credentials the dean took me to the experimental laboratory and pointed out the "offending thing" as he termed it, saying that it was of the utmost importance that the trouble be speedily remedied because it was nearly the end of the term and the boys were in the middle of an elaborate test which must be completed before college closed in order to write a "summer thesis." He could not explain what the trouble was except that "the thing" was out of kilter.

I put "the thing" through its different stunts and detected a peculiar jarring knock at the end of each stroke of the hydraulic plunger and decided that either the bronze casing of the plunger or the bushing of the cylinder was loose. After dismantling it I found the bushing loose. I reported to the dean that the best I could do was to have the makers cast and machine a new bushing which would take at least a week.

"Good Law!" exclaimed the dean; "exams begin in one week and we want the thing fixed and final tests made by that time."

I explained as well as possible that it was unfortunate I was not born twins so that I could be here finding trouble and at home remedying it. He was too busy at the time to decide finally what was best but said that it was getting late and he would sleep on it.

After going to the hotel and to bed I pondered over the matter and finally struck a bright idea. I dressed and went down to the college. Between the night watchman, the night fireman and myself after distributing some cigars, I had a boss and two good helpers. I improvised a boring bar and instead of a cutting tool used a roller, piece of iron pipe and bearing as shown in Fig. 1, and ran it through the cylinder bush a few times and found that it was as tight in the cylinder as a pressed fit, but to my dismay it was out of true. We then put a cutting tool in the boring bar and took a light cut truing the bore up. I should mention that before this I noticed a new sleeve, not machined, that had been purchased the previous year for the plunger. This I now turned and bored to the required size and pressed it on the plunger instead of the old one.

When the dean came about 9 a.m. (it was about 8:55 a.m. when I got everything completed) he said that he found on sleeping on it that he would abandon the idea of repairs until the summer vacation.

When I told him that he need not wait as "the thing" worked all right, and proved by demonstration that such was true he showed his appreciation with a box of very fine Havanas. I noticed when I first examined the bushing that it was soft, while rolling it in my kneading machine it became very hard. Last year I had occasion to go out on a job where the cast-iron cylinder of a Corliss engine was too soft and the bullring was just cutting the mischief out of it. College days returned and the old boring-bar scheme was resorted to again.

Instead of using a roller in place of the cutting tool I made a "bulging" tool (Fig. 2) for want of a better name and after fastening it in the boring bar went over the cylinder bore several times, feeding slowly. This I found crystallized the cast iron while not materially enlarging the bore and have not heard a "kick" from the owners since. Horse sense is some good and more good if used oftener.

Canton, O. G. E.

An Offset Drilling Attachment

This attachment has been in almost daily use in our shop for over ten years. It is used for drilling set-screw and oil holes in pulley hubs and obviates the necessity of drilling through the rim.

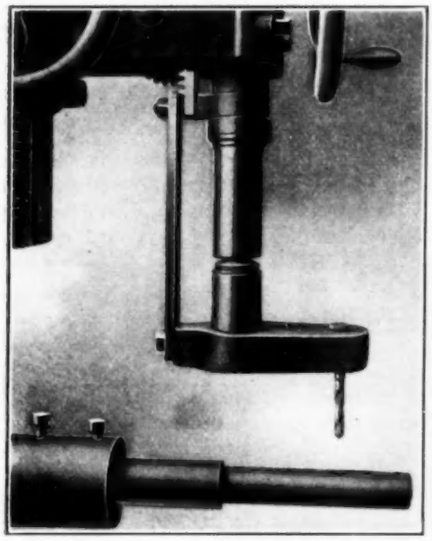


FIG. 1. THE FIXTURE IN PLACE

Fig. 1 shows how it is applied to the drill press. The table is swung out of the way and an arbor, shown below the drill, is secured to the column of the drill press. By using suitable bushings this arbor accommodates any bore of pulley.

The detail of the attachment is shown in Fig. 2. The flat bar at the back not only prevents any tendency to turn, but prevents any tendency the front end may have to lift when the drill is under pressure. From the center of the drill-press spindle to the center of the drill is about 4¾ inches, quite enough reach for any work we have.

The tool was designed by Mr. Sawyer, foreman of the Baxter D. Whitney & Son's shops.

Winchendon, Mass. J. E. A.

A Machine for Demonstrating

The three half-tones show a little machine which was used to demonstrate the handiness of the "press-button" knife. A description of how this knife is made was published in the AMERICAN MACHINIST some five years ago. This machine was designed by Geo. Schrade the inventor of the "press-button" knife.

Fig. 1 shows the complete machine. Fig. 2 shows a side view with the sides and ends removed. Fig. 3 shows an end view with wiring for the small electric motor.

In demonstrating the advantage of opening a blade of a "press-button" knife with one hand only this feature was clearly shown, but the operator's hand concealed such a large portion of the knife that it was not satisfactorily shown. This machine was then made and put in operation and proved such a wonder in showing up the essential points of the "press-button" knife, that it was exhibited in different cities all over the United States. These little machines were shown in several large exhibitions very successfully from a financial standpoint, viz.: It increased the sales of the goods enormously.

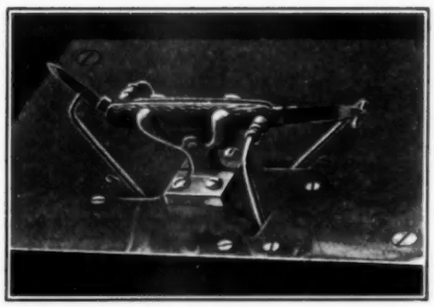


FIG. 1. GENERAL VIEW

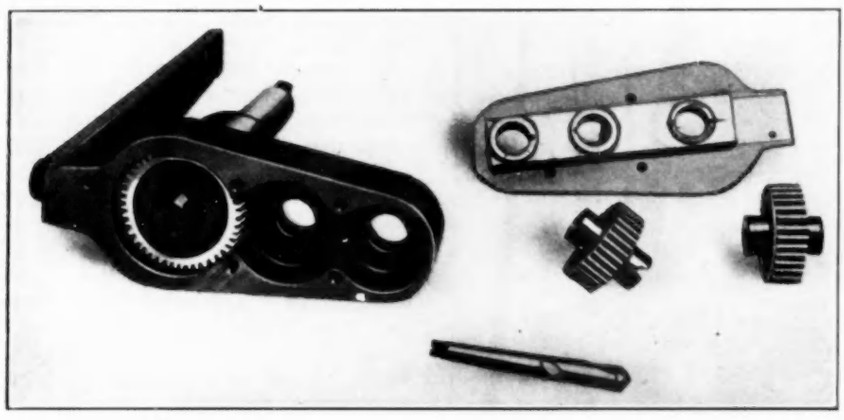


FIG. 2. THE PARTS

The machine in Fig. 1 shows one blade open and the other being closed by the mechanism which alternately moves the rocker arms shown more clearly in Fig. 2. These rocker arms are constructed so that their weight causes them to hold the steel arms always in a position for reopening, so that when the blade is closed by the machine they drop instantaneously into position for reopening.

To open the blade of a "press-button" knife you press the button and the blade

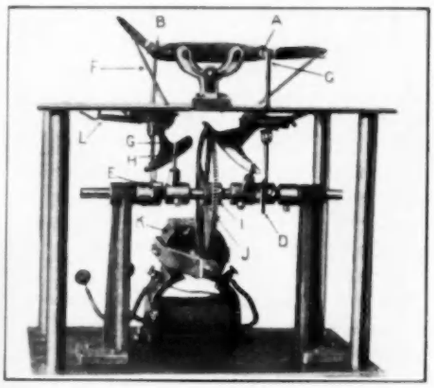


FIG. 2. SIDE VIEW OF THE MACHINE

flies open, and is locked in that position. To close it again you must press the button and then push the blade back into inclosed space. Therefore to accomplish these results on the machine the same movement had to be followed that the hand would naturally take.

To open the "press-button" knife on the machine the steel rod *C* is pressed against the buttons at *A*. This steel *C* is moved at *D* by the cam *E* on the shaft *I*. As the blade is opened a concealed spring locks it open and it cannot be closed until the button is again pressed by the steel rod *C*, then simultaneously the other steel rod or arm *F* pushes up the blade and closes it from the action of the rocker arm *G*. This rocker arm *G* is moved by the action of the steel pin *H* which is fastened in the casting on shaft *I*. This shaft *I* is rotated by worm gear *J* which is driven direct from motor *K*. The springs *L* continually pull the

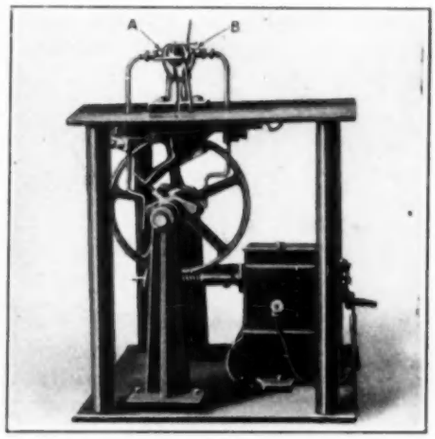


FIG. 3. END VIEW

steel rod *C* away from the buttons in the knife.

The spring which causes this blade to fly open is not connected in any way with the machine but is in every "press-button" knife made, and the machine is so constructed that any knife in stock can be placed in the machine, and opened or closed just as effectually.

Yonkers, N. Y. G. P. CAMPBELL.

A Home-made Cold-saw Grinder

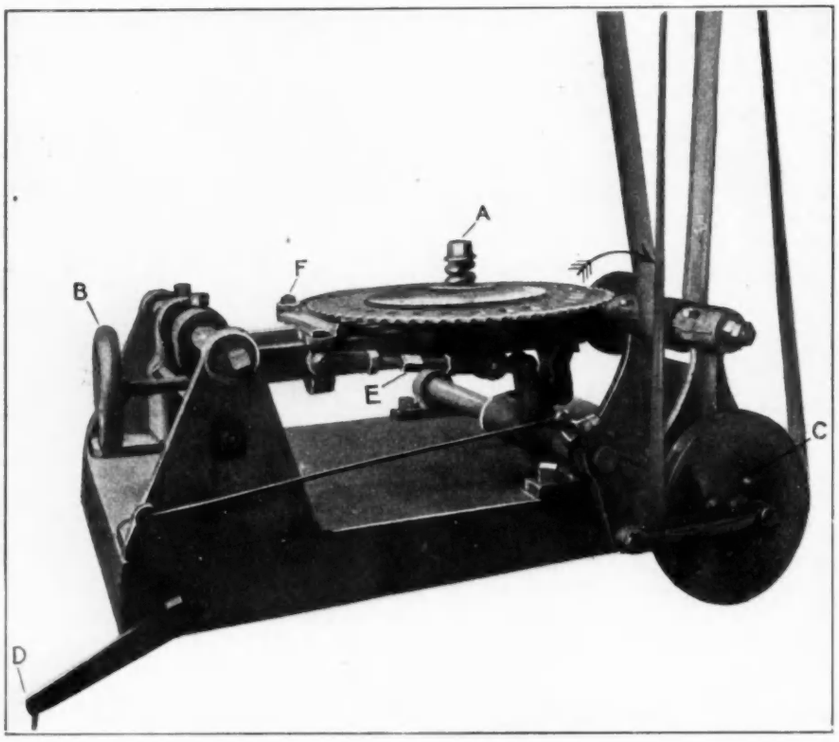
Recently, when looking over a machine shop which was being dismantled preparatory to an auction sale, I discovered the saw grinder shown in the accompanying half-tone.

Most of the parts on the machine had evidently been made expressly for it, though some of them were "pick ups" from the scrap pile.

A shows how the saw is held firmly in place while being fed past the wheel, by a heavy spring pressing against a cast-iron disk. The grinding and indexing of the saw is entirely automatic except that it must be fed in by using the hand wheel *B* at each revolution of saw. The saw may be ground either on the top or the face of the tooth. Means for adjusting the indexing dog are provided at *E* and *F*. Emery wheels of various sizes may be used and the stroke varied by using the different spaced holes indicated by *C*.

The lever *D* is weighted and its action counterbalances the weight of the saw and its supports and also prevents lost motion in the stroke.

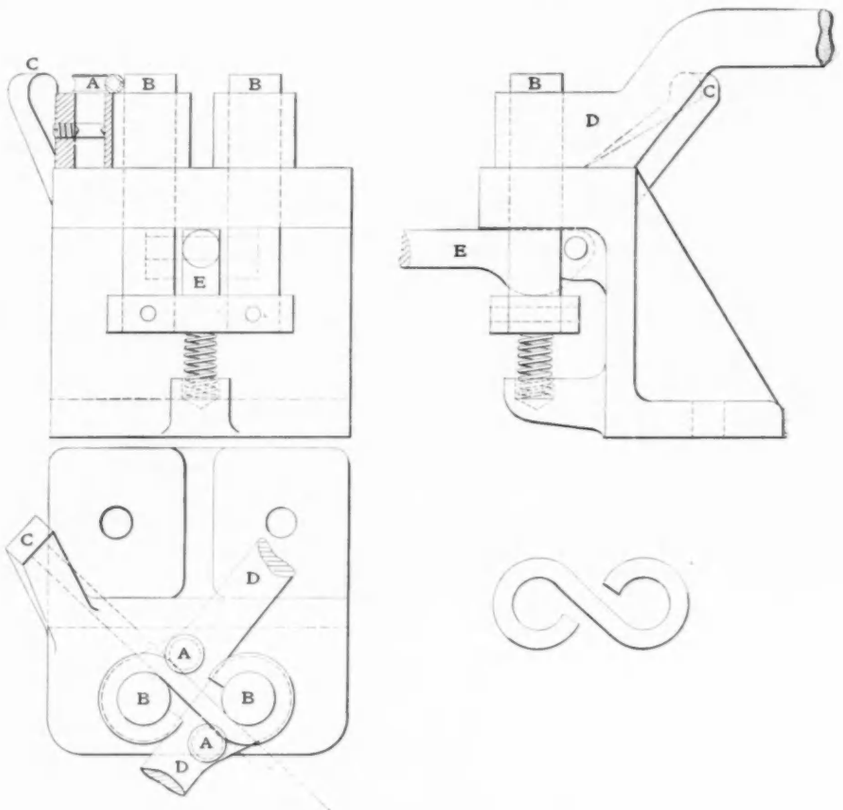
Decatur, Ill. ETHAN VIALL.



A HOME-MADE SAW GRINDER

Simple Fixture for Making "S" Hooks

In a shop where I was recently employed we had an order for several thousand S-hooks to be made from 5/16-inch rod to a sample. Calculating the smith's time to make them we found we were hopelessly out of it compared with the price they could be bought at. The merchants quoted delivery in 6 weeks, but we wanted them and got them too, in as many days.



FIXTURE FOR BENDING S-HOOKS

So I designed this fixture shown, and with a lad to work it we turned them out at the rate of 1200 a day to the complete satisfaction of everyone.

The sketch almost explains itself, I think. The method is to push the length of rod between the rollers *A* and the formers *B* up to the stop *C*. Both levers *D* which were 2 feet long, are pulled at once, otherwise the rod will slip round the "former" with the roller and spoil the bend. When both levers are round as far as they will go, the cam *E* is pressed down and the finished hook released. The levers are then brought back again as far as they will go and the next rod inserted.

Birmingham, England. M. BROWN.

A machine of Scotch invention, and operated by a gas engine, for milking cows, was introduced on a large farm in England last year, and is reported to have proved a practical success. One man and one boy were enabled to milk 70 cows in one hour and a half, and aside from the hygienic advantage over hand work the saving in cost of labor is expected to pay for the machine in two years.

Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

Profitless Haste

The article on "Profitless Haste" on page 627, Vol. 31, Part 1, surely "hits the nail on the head." Who is there among us who has not seen these conditions with the results mentioned; money and time worse than wasted?

The writer might have called attention to another phase of the subject; that is, the production of work in the shop and designing office under abnormal pressure. Some official issues instructions that a certain machine must be completed, or a certain order must be filled, at a given time, when nothing short of a miracle can accomplish it. Probably no tools or jigs for economical production have been made or even designed; but this was not taken into account by the official. Double rush orders throw all departments into chaos in the endeavor to produce in profitless haste. No time can be taken to complete efficient tools and crude "makeshifts" are resorted to, in order to make some showing on the job. Night and Sunday work is ordered and soon the men, from long hours, become stupid and inaccurate. Such a situation ought never to exist in any shop.

From these conditions there pours into the inspection department a mass of finished parts that are fit only for the scrap heap, and the main reason they don't get there is because the inspector is afrad of losing his job if he doesn't pass them.

The results of such methods are easily seen; poor products, dissatisfied customers, falling off of sales and decreased dividends. How much better it is to undertake a reasonable amount of work with time enough to finish it with credit and have the opposite results; good products, satisfied customers, increased sales and dividends.

There is one other place where "profitless haste" works great evil and that is in the drafting department. The completion of plans or designs are demanded within an unreasonable time. In trying to meet these demands the draftsmen are worked under a nervous strain which is conducive to poor design, gross errors and illegible drawings. I do not advocate the adoption of slow, plodding methods in production, but appeal rather for rational methods within the bounds of reasonable possibility. The old saying, that "haste makes waste" may seem trite, but it still holds true.

Buffalo, N. Y. J. C. AUSTIN.

Milling Machine Change Gears without Mathematics

Referring to Professor Peddle's article on the "Construction of Graphical Charts," page 753, Vol. 31, Part 1, I am pleased to say that I have read it with great interest. I have been trying for a long time to construct a chart that will be of great help to draftsmen and milling-machine operators, even though it will not be used constantly. Professor Peddle's knowledge of the theory of their construction may be able to help us out, and thereby add another page to his valuable contribution.

The conditions are as follows:

We wish to cut a spiral on the milling machine; to do so we select proper

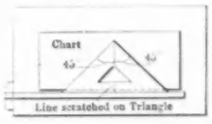


FIG. 1

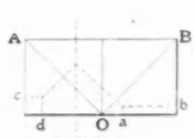


FIG. 2

CELLULOID TRIANGLE USED AS A TRANSPARENT INDEX AND DIAGRAM SHOWING CONSTRUCTION OF CHART

change gears, giving the required lead, from the table furnished with the milling machine. Often the table does not give a set of gears for our lead that are desirable, hence they have to be calculated, and we all know what a tedious job that is. Here is where we would like a chart.

The change gears for a milling machine usually start with 24 teeth and end with 100 teeth. Many shops have all gears on hand between these limits. The formula for the lead may be written thus:

$$10 \times \frac{a}{c} \times \frac{b}{d} = lead,$$

a, b, c and d, of course, are the unknown quantities and may be any whole number from 24 to 100. For the lead, we multiply the compound gears by 10 to compensate for the worm reduction in the spiral head, also for the screw in the table.

Therefore, given our lead and wanting the gears, if all we had to do was to locate the nearest lead on the side of a chart and then run off on diagonals or horizontals to the required gears all would be very easy and pleasant.

GEO. W. HAYDEN.

So. Dartmouth, Mass.

[Mr. Hayden's letter was sent to Professor Peddle; we are pleased to print below his reply and a most useful chart. —ED.]

The accompanying chart is the best solution of Mr. Hayden's problem I have been able to concoct. It is not completely satisfactory to me, but I doubt if a better one is possible. I have gone over the subject pretty carefully, and have tried quite a number of different plans, all of which had defects of a more or less pronounced character.

The solution is one of the methods "of the transparent index." Mr. Hayden's formula to which it applies is

$$10 \frac{a \times b}{c \times d} = lead,$$

and is applied to getting the lead of a spiral to be cut on a milling machine. In it a and b are the numbers of teeth on the followers of a compound gear, and c and d are the numbers of teeth on the drivers.

In my chart the top line is graduated to represent the logarithms of the leads. The lower and side lines are graduated to double this scale to represent the logarithms of the numbers of teeth in the various gears. These last graduations, for convenience, are repeated on the diagonals.

To read the chart a transparent index is necessary, which is best made on celluloid. On it three lines are ruled meeting at a point, the outside lines each making 45 degrees with the middle line. The index is laid on the chart so that the middle line is vertical and passes through the desired lead on the upper scale. The vertical lines in the middle of the chart are merely for the purpose of orientation, and have no other use. The index is then slipped up or down on the line until one of the side lines passes through the intersection of a vertical and horizontal line from two of the gear-tooth scales. The other side line is then examined, and if it also passes through an intersection the numbers on the intersecting lines will be the teeth on the remaining gears. If no intersection is found on the second line the index must be moved up or down until a simultaneous intersection is found on the two side lines.

For the size of chart as published a large 45 degree ambro triangle will serve as the index. It should have a line scratched on the under surface bisecting the 90-degree angle, and have its long side laid against the horizontal edge of a T-square. See Fig. 1.

For illustration, lines have been drawn to show a solution for a lead of six. The

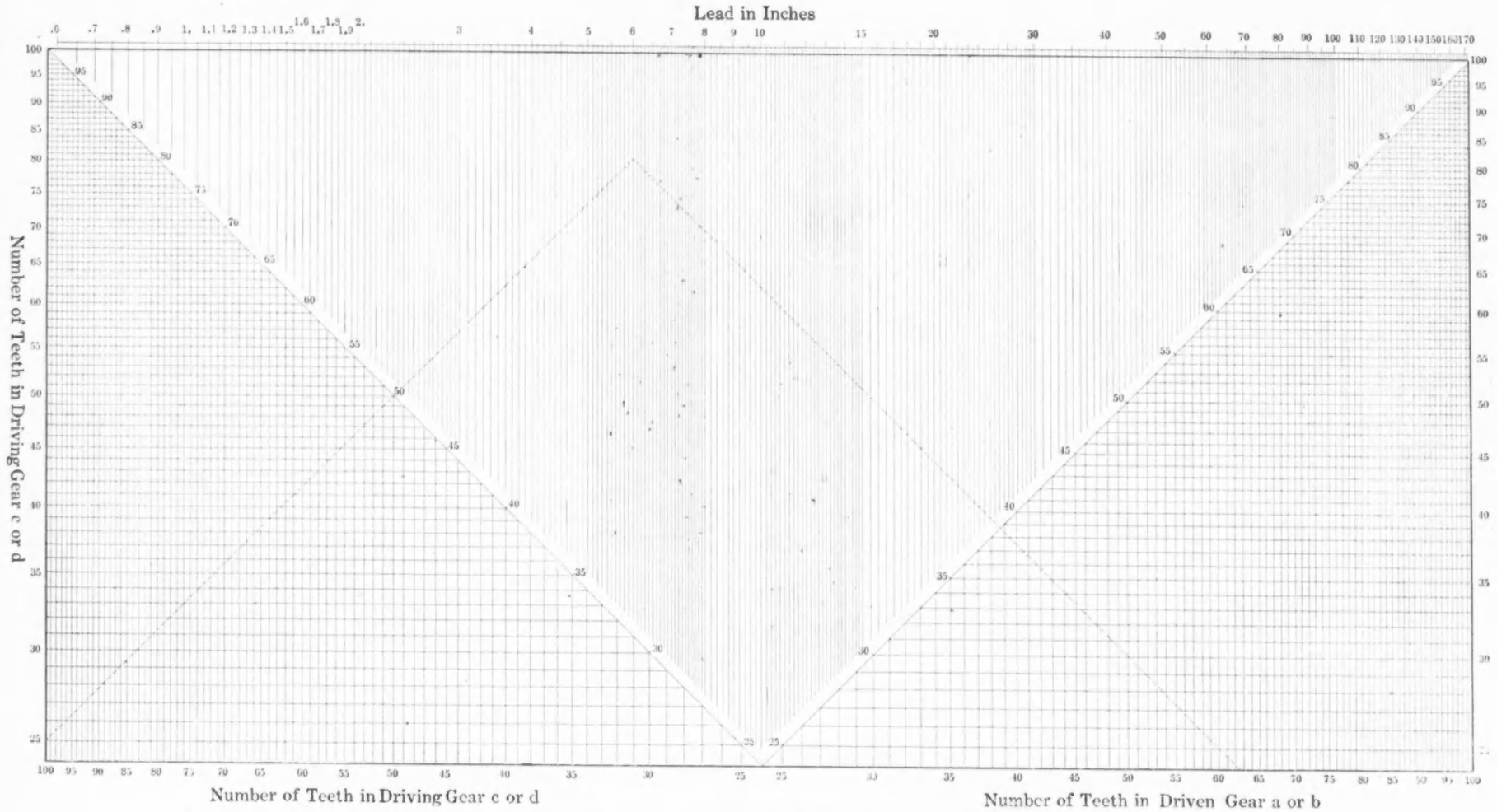


CHART TO DETERMINE MILLING MACHINE CHANGE GEARS FOR VARIOUS SPIRAL LEADS

left-hand 45-degree line passes through the intersection of 50 and 50 from the gear-tooth scales, and all the other intersections with lines from the same scales should have the same product, 2500. On the other 45-degree line two intersections will be found, one for 50 and 30, the other for 60 and 25. The product of each pair is again a constant, 1500.

According to our formula,

$$10 \frac{1500}{2500} = 6.$$

Other possible combinations will be found on the left-hand diagonal, and here it should be noted that since the values are measured and read as the lengths of lines, the accuracy of the diagram like that of the slide rule is limited. The index line may sometimes pass so close to an intersection that, from the thickness of the lines concerned, it is difficult to say whether or not the intersection is exact. For accurate work, therefore, it is probable that the chief use of the diagram will be suggestive. The results obtained should be checked by multiplying the figures obtained to see whether they are within the required limits, and the diagram should be looked upon as a rapid method of obtaining probable values, thus saving time which would otherwise be wasted in cutting and trying.

For instance, as I said before, the products of the numbers intersecting on the left-hand line should be 2500. Examining it we find apparent intersections at $49 \times 51 = 2499$, at $48 \times 52 = 2496$, at $58 \times 43 = 2494$, at $61 \times 41 = 2501$, at $64 \times 39 = 2496$, at $32 \times 78 = 2496$, at

$29 \times 86 = 2494$, at $26 \times 96 = 2496$, and at $25 \times 100 = 2500$.

It may be of interest to state briefly the principles on which the chart was constructed.

In my article referred to by Mr. Hayden, Fig. 8 showed the method of multiplying on logarithmic paper. On the present chart will be found two halves of such a diagram. The remaining halves are unnecessary since they will merely duplicate the results. Lines at right angles to OA or OB in Fig. 2 will, therefore, be lines of constant product for cd and ab. The values of these products might be graduated on OA and OB where the lines meet them, but as this is unnecessary it has not been done. The value of the unit for graduating on OA or OB would be $\frac{1}{\sqrt{2}}$ times that on the gear-tooth scales. OA and OB might now be taken as new axes and perpendiculars erected to them for the purpose of multiplication or division. The horizontal lines on which these perpendiculars intersect would be new lines of constant product, while the verticals would represent constant quotients. This latter are what we want and are the ones used; their intersection with a horizontal will give the values of the quotients. The scale value on the new horizontal is again $\frac{1}{\sqrt{2}}$ times that on OA or OB, or

$$\frac{1}{\sqrt{2}} \times \frac{1}{\sqrt{2}} = \frac{1}{2}$$

that on which a, b, c and d are measured. Since the arbitrary factor of 10 is introduced in our formula, the values of the numbers thus located on the upper line must all be divided by 10 in determining numerical values.

The principles on which this chart is based present no features which are novel, but it should be stated that the particular form adopted is the result of a suggestion made to the writer by Prof. A. S. Hathaway.

Terre Haute, Ind. JOHN B. PEDDLE.

Power Calculations for Electric Vehicles

In the article, "Power Calculations for Electric Vehicles," on page 86, there are several points which seem to me well worth discussion. I notice first a table of weights of vehicles. These may be correct, but a similar table for gasolene vehicles would differ from it so much that if, as the writer says, "it is possible also to use this data for gasolene vehicles," the weights of the latter must be given also. Another item which Mr. Aitken has neglected to give is the load. This he takes in each case as equal to the rated load, whereas trucks are almost invariably overloaded. Many manufacturers consider this overload when figuring the power equipment.

Under those circumstances I would amend his Table 1 to read as in the accompanying Table 1:

Rated Carrying Capacity.	Vehicle Weight in Pounds.		Average Actual Load in Pounds.	Total Weight, Pounds.	
	Electric.	Gasolene		Electric.	Gasolene.
1000 pounds	3,660	1,600	1,200	4,860	2,800
1 ton	4,900	3,200	2,400	7,300	5,600
2 tons	6,840	5,000	4,800	11,640	9,800
3 tons	8,000	6,000	7,200	15,200	13,200
4 tons	9,000	7,000	9,600	18,600	16,600
5 tons	10,000	8,000	12,000	22,000	20,000

TABLE 1. CARRYING CAPACITY AND WEIGHTS OF MOTOR VEHICLES.

Similarly, with the table of speeds given as his Table 2. These speeds, as given for electric vehicles, are about right, but for the lighter gasolene cars we find slightly higher speeds used throughout the list.

This, as amended, would be as shown in the accompanying Table 2:

Capacity.	Speed in Electric.	Miles Per Hour Gasolene.
1000 pounds	12	18
1 ton	10	16
2 tons	8	14
3 tons	7	12
4 tons	7	10
5 tons	6	8

TABLE 2. SPEEDS OF VEHICLES.

Next we come to the formula,

$$horse\text{-}power = 0.0026\ S.\ W.\ T.$$

The derivation of this is not given so we can only judge of it by results. Thus let us figure according to the method given the power required to propel a 5-ton truck (electric) at 6 miles per hour, capable of climbing a 6-per cent. grade, shod with Hartford tires and used mostly over cobblestones. The total weight, vehicle plus load, is 11 tons. The speed, 6 miles, gives us a tractive effort of 20. The grade, 6 per cent., adds 120, total 140. Hartford tires have a factor given in his Table 4 of 1.35. Using this the tractive effort becomes $1.35 \times 140 = 189$. For the road surface, the factor for cobblestones is given as 1.72; using this $1.72 \times 189 = 325$. We must add a factor to take care of the efficiency of the transmission. Suppose we use a single motor driving by chain and a countershaft on roller bearings, with double side chains to the wheels. Then, as per his Table 3, three roller chains at 6 per cent. loss = 18 per cent.; two roller bearings at $\frac{1}{4} = \frac{1}{2}$ per cent.; total, $18\frac{1}{2}$ per cent. loss.

The tractive effort found above, 325, plus $18\frac{1}{2}$ per cent. of $325 = 385$. Therefore,

$$horse\text{-}power = 0.0026 \times 6 \times 11 \times 385 = 66.$$

Who ever saw an electric truck with a 66-horse-power motor? The conditions as selected do not seem excessive.

The writer stated that his formula was applicable to gasolene vehicles so let us look into a similar 5-ton gasolene truck; transmission, 3 speeds and reverse, plain bearings, bevel-gear drive to countershaft, double side chains to rear wheels, countershaft on roller bearings; speed, 8 miles per hour; total weight 10 tons; maximum grade 6 per cent.; Hartford tires and cobblestone pavement. The transmission loss will be (if we have direct drive on high speed) 2 plain bearings at $2\frac{1}{2}$ per cent. = 5 per cent., bevel gears 12 per cent.; 2 roller bearings at $\frac{1}{4} = \frac{1}{2}$ per cent., 2 roller chains at $6 = 12$ per cent.; total, $29\frac{1}{2}$ per cent. If we do not have direct drive we will have to figure on 2 pairs of spur gears at 8 per cent. = 16 per cent., and 4 instead of 2 plain bearings at $2\frac{1}{2} = 10$ per cent., giving an alternate total of $50\frac{1}{2}$ per cent. Let us be charitable and take the smaller figure of $29\frac{1}{2}$ per cent.

Our tractive effort for 8 miles per hour is 18 plus 120 for 6 per cent. grade = 138. Add for transmission $29\frac{1}{2}$ per cent. gives 179. Multiply by 1.35 for tires gives 242. Multiply by 1.72 for road conditions giving 416 pounds per ton. Then

$$horse\text{-}power = 0.0026 \times 8 \times 10 \times 416 = 86.5.$$

To my knowledge there are very few trucks having this amount of power. Yet one that I know of in this town, a 3-ton machine, which normally carries 7500 pounds load and is geared to 14 miles per hour, climbs a 11.2-per cent. grade with full load three times per week as regularly as a clock. This grade has a very poor macadam pavement which would class as about equal to the best cobblestones. Two street-car tracks that must be crossed are paved with cobbles. Sometimes when the road is wet the driver follows the car tracks up the hill.

To come back to the article in question I think that the figure used in the horse-power formula is too high. The other figures given in his Table 3 are some of them in error. For instance, roller chains have 6 per cent. loss. T. Huyler White in "Petrol Motors and Motor Cars," says, "with roller chain drive under favorable conditions the efficiency is 98 per cent." Note he says, "favorable" and not most favorable or exceptional! This would only give a loss of 2 per cent. instead of 6 per cent.

Similarly, with silent chains, both the Link Belt Company, that makes the Renold silent chain, and the Morse Chain Company, that makes the Morse chain, give 99 per cent., and will install under a guarantee of more than 98 per cent. The

former is 1 per cent. loss and the latter 2 per cent., instead of the 3 per cent. given. As to spur gears, Wilfred Lewis, in the experiments made for Wm. Sellers & Co., over ten years ago obtained an efficiency of 98.6 per cent. at 200 revolutions per minute, which included the journal friction; so it would certainly be fair to use this value for the gears alone. This figure, 98.6, would give 1.4 per cent. loss instead of 8 or 10.

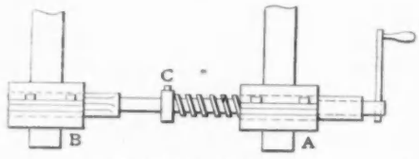
Mr. Aitken's article was very interesting and on an up-to-date subject, but I feel that it might be improved by the additions given here.

Allentown, Penn. MORRIS A. HALL.

A Hand-reaming Device

In one of the erecting rooms of a textile machinery shop, a number of pairs of bearings have to be reamed in line with each other. They have a clever little device for hand reaming them. There is a standard bar on which can be placed different sizes of shell reamers, and different sizes of bushings that serve as guides for the bar.

The fixed bearing is indicated at *A* in the cut and *B* is the one to be reamed in line with it. The erecting hand selects a bushing the size of the hole in the bearing *A*, puts it on the bar, places the bar in the bearing and tightens down the cap so that the bar will turn freely without any shake. With a bar of steel for a lever he pushes the collar *C* back, thus puts the spring under compression, and makes the collar fast by means of a screw. On turning the bar by the handle the spring feeds the reamer through very evenly.



A HAND-REAMING DEVICE

Many of these bearings come in such a position that a full turn of the handle cannot be had; a ratchet handle is put on and then the spring feed is particularly handy.

Lowell, Mass. PAUL W. ABBOTT.

Core-making Kink

Under the heading "A Difficult Core" on page 97 of the AMERICAN MACHINIST, Wilfred George describes a method of making a core model, for a box-iron chimney, by drilling away the desired thickness of stock from a solid casting.

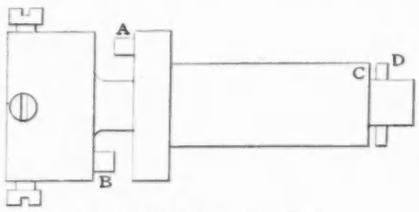
I should like to suggest a method that while well known to metal patternmakers may be new to many of your readers. This is, if instead of securing two castings from the wood pattern he had used the second mold to secure a plaster cast from, he could have saved much time and labor.

By cutting grooves in the plaster, about one inch apart and of a depth equal to the desired thickness of the wall, he could have cut away the remaining plaster and followed the contour of the casting very accurately.

Cleveland, O. B. A. DEMUTH.

Why Clutch Pins Engage on Tap and Die Holders

At page 881 of Vol. 31, Part 1, G. Harfman wishes to know why the clutch pins *a* and *b*, in the accompanying sketch,



THE TAP AND DIE HOLDER

engage again when the countershaft has been reversed. The reason is, the turret is not allowed (by the operator) to come dead up to its stop, before the die holder is released. This is a practice most operators soon get into. It is done by a slight jerk on the turret star which causes the clutch pins *a* and *b* to disengage, and then the countershaft is reversed, and the turret is brought dead up to its stop by a slight movement of the operator's hand on the turret star, which causes the clutch pins *a* and *b* to engage. The reason the above system or method is preferred by the operator is that it keeps the pin ends in better condition and they are not so liable to slip past each other and break a small tap by causing sudden jerks. The above is also preferable to having a cam provided at *c*.

Darlaston, Eng. H. MAPLETHORPE.

Direction of Rotation of Epicyclic Gears

Mr. Beal's remarks on the above subject, on page 39, interested me very much, also the reprint of Professor Woods' article. I have had some experience with this kind of gearing and have used a formula for several years that I have never seen in print. It seems to be more concise in form, although identical in principle, than the one given by Professor Woods.

Referring to Fig. 1, which is the same in principle as Fig. 5 in Professor Woods' articles, although it shows two studs on the arm *A*:

F is the stationary or dead gear,
L is the gear to be driven,
C and *D* are planet gears mounted on the stud *G* and fastened together so that they rotate as one gear.

Let R = the ratio of rotation between *A* and *L*.

Consider *F* as the first driver,
C as the first driven,
D as the second driver and
L as the second driven.

Then

$$R = 1 - \left(\frac{F \times D}{C \times L}\right).$$

The direction of rotation of *L* will be the same as *A* when R takes the plus sign; opposite when R takes the minus sign.

To illustrate; let the number of teeth on the several wheels be $F = 38$, $C = 40$, $D = 38$, $L = 40$. Substituting these values in the above formula we get

$$R = 1 - \left(\frac{38 \times 38}{40 \times 40}\right) = 1 - \tfrac{361}{400} =$$

$\frac{400}{400} - \frac{361}{400}$. Then $R = \frac{39}{400}$

and the direction of rotation of *L* is the same as that of *A*. Now transposing these gears so that $F = 40$, $C = 38$, $D = 40$, $L = 38$ and we get

$$R = 1 - \left(\frac{40 \times 40}{38 \times 38}\right) = 1 - \tfrac{400}{361} =$$

$\frac{361}{361} - \frac{400}{361}$. Then $R = -\frac{39}{361}$

and the direction of rotation of *L* is opposite to that of *A*.

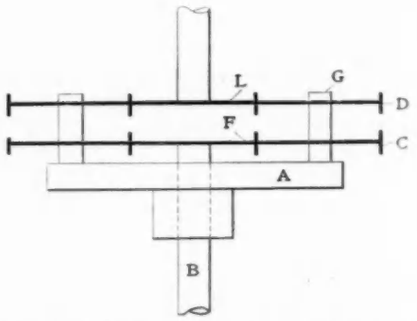


FIG. 1. DIAGRAM ILLUSTRATING EPICYCLIC GEARING

The above formula is all that is required to determine the ratio and direction of rotation but there are limiting conditions involved that it may be well to point out to help in establishing the conditions indicated in Fig. 1. The arm *A* rotates around the stud *B*. It may carry one stud *G*, or two studs. In practice *A* usually carries two studs diametrically opposite and two pairs of gears, as indicated in the diagram, to maintain a mechanical balance. The using of two studs and two pairs of gears, it should be noted, limits us somewhat; for with one stud and one pair of gears *C D*, the difference between *F* and *L* may be reduced to one tooth, but with two studs and two pair of gears the difference cannot be less than two teeth. This brings up another limiting factor in the problem, that must not be forgotten in laying out a train of

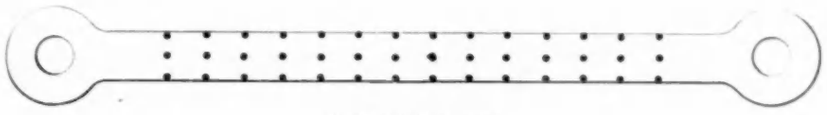
these gears; that is, that the center distance between C and E must be the same as between D and L; hence $C+F$ must equal $D+L$ or else require gears with mongrel teeth. I have used, and known others to use gears enough off standard to have F and L with a difference of one tooth when using one stud, but that is as far as I have ever known this practice to be carried.

Professor Woods appears not to have considered this phase of the subject, for, taking the last example in his article, page 42, he gives $F+C=67$ and $D+L=62$ which is a difference of 5 teeth. This is hardly permissible in practical construction although mathematically correct.

Greenwich, Conn. K. S. AUGMAN.

Welding Eye-bars

Henry Barnes, on page 949, Vol. 31, Part 1, gives a welding kink. Here is another: A bridge builder brought 12 pieces shaped as shown in illustration, about 20 feet long, made of 1x5-inch flat bar, all 6 inches too short. The orders were to cut any place between eyes and weld in 6 inches. Apparently this meant 24 cuts and 24 welds. The smith did it with 13 cuts and 13 welds. He cut out pieces about 3 feet from one end. Next he cut the short piece 3 feet 6 inches longer, then he welded the short piece of the second one onto the long end of the first one. Then short end of third to long end of second. So on to the last



WELDING EYE BARS

when he took the first short end and the remaining end of last and cut one piece from stock to make the required length.

Decatur, Ill. W. A. BRIGHT.

A Circular Forming-cutter Problem

At page 443, Part 1, appears an inquiry from J. G. Owen asking for a method of figuring out a way to make a circular forming cutter to cut a groove with an angle of 60 degrees, when the cutting edge of the cutter is ½ inch below its own center, and at the center of the work. If Mr. Owen makes a lathe tool with a V-shaped face to it, the angle of the V being 60 degrees, or whatever the form of the groove, or form of the work has to be, and finishes the blank of the circular cutter with this, keeping the cutting edge of this tool ½ inch below the lathe centers, the circular cutter will reproduce the V-shaped groove exactly, whatever its angle, without any calculation. This will be found a true way of making any circular forming cutter, provided the cutting edge is applied to the work at exactly the hight of the lathe centers.

JOHN HUBBARD.

Paeroa, Auckland, New Zealand.

A Job-shop Experience

Jack's experiences, given at page 992, Volume 31, Part 1, seem so life-like that I was intensely interested. Yet I cannot agree wholly with the conclusion drawn. Jack tried to do two things at once; either of them might have floored a very good man. He tried to run a job shop without money, and he tried to run a manufacturing business without money. If he had only had the nerve of some modern promoters to enable him to conceal his lack of money, then he might have succeeded in either attempt alone. But then if he had had that amount of nerve he would have struck into something besides a machine shop.

It is evident that what Jack was interested in was gas engines. He did jobbing to raise money to build gas engines. He ran the job shop only as a side issue and in a town where there were three other shops for every job. It is a wonder that he got as much to do as he did. Then, he was evidently all alone. He had to be financial manager, which is always a hard job when there is no money to finance with, and shop manager, too. The fact that he was well qualified for the latter ought to have made him wonder if he was fitted for the former. If he was not fitted for that part of the job he ought to have waited until he could pick up some other young fellow with a head for money and no shop knowledge. Then what did he do but try to butt into an old business with a new engine that no one knew anything about, to compete with large, organized factories and to build his engines one at a time. Mr. Ziegler does not say so, but I would bet as much as a nickel that by the time he shut up shop he had patterns almost done for at least a dozen sizes or styles.

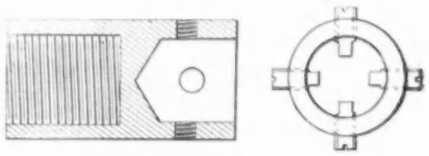
That chap, Jack, is just exactly as I was until I got the wind knocked out of me. I could always see a golden lining to the cloud next beyond the one I was in. As a matter of fact, the cloud that you're in is the one whose golden lining you want to find. The chances are it is there, too. Just dig lively into whatever there is about your job that you have turned up your nose at in the past, and the chances are that you will find just what you need to make yourself of some use to this old world.

Fitchburg, Mass. ENTROPY.

Re-turning Drill Shanks

I have read with considerable interest the articles regarding the twisting off of drill tangs, but have failed to notice any device for repairing them. I illustrate here a fixture which I have used very successfully for many years.

It is a machine-steel sleeve threaded to



RE-TURNING DRILL SHANKS

fit the lathe spindle. The other end is bored to receive the point of the drill. The four set-screws are used to center the drill the same as a four-jaw chuck, two screws resting on the edges of the drill, the other two in the flutes. The other end of the drill is run in the steady rest beyond the flutes. Then the end of the drill is faced off where it is broken, recentered, the steady rest is removed, the taper attachment is thrown in, and by a little careful work a new shank can be turned which will answer the purpose nicely.

It will be necessary, in most cases, to dip the drill shank in a lead bath to anneal it before turning.

Auburn, N. Y. A. D. MUNDY.

[It would be cheaper to use one of the new sockets in almost any case, and the economy of this plan is doubtful in most cases.—ED.]

An Unique Belt Shifter

On page 981, Vol. 31, Part 1, is described a new German belt shifter. A similar device has been in use in the factory of the Brown & Sharpe Manufacturing Company, Providence, R. I., for the past 25 years, and, no doubt, the same thing can be found in many other shops in this country. The patents have probably expired, but information on this point can be obtained from Chandler & Farquhar, Boston, Mass.

Providence, R. I. D. D. DONOVAN.

An unusual order consisting of vitrified emery wheels with 26-inch face has recently been successfully filled by the Pittsburg Emery Wheel Company, which is the second contract of this kind that this company has carried out.

The trustees of the University of Illinois have recently let the contract for a new building for its college of engineering, to be occupied wholly by the department of physics, the structure to cost, with its equipment, $250,000. It is to be erected just east of the present Engineering building.

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Treaty With Japan Relating to Patents in Korea and China

On August 6th the exchange of ratifications was made at Tokyo in regard to the recent convention with Japan, relating to the protection of trade marks, copyrights, inventions and designs in China and Korea. Its provisions go into effect 10 days after this ratification.

The articles referring to Korea provide that the Japanese Government shall cause to be enforced in Korea, simultaneously with the operation of this convention, laws and regulations relative to inventions, designs, trade marks and copyrights similar to those which now exist in Japan. The United States waives its extra-territorial jurisdiction in cases of infringement by American citizens of inventions, trade marks, etc. entitled to protection in Korea. This places the consideration of such cases of infringement under the exclusive jurisdiction of the Japanese courts in Korea. Inventions, designs, trade marks and copyrights duly patented or registered in Japan by citizens of the United States, prior to the enforcement of the laws and regulations that Japan is bound by this convention to establish in Korea, shall be entitled to the same protection in Korea as is, or may be, accorded to the same properties similarly patented or registered by Japanese or Korean subjects.

The articles relating to the protection of trade in China provide that inventions, designs and trade marks, duly patented or registered by citizens of the United States in the appropriate office of Japan, shall have in all parts of China the same protection against infringement by subjects of Japan that is accorded to them in Japanese dominions and possessions. Japanese inventions, designs and trade marks duly patented or registered in the United States receive similar protection against infringement by United States citizens throughout all parts of China. Trade marks falsely used by any persons amenable to the provisions of this convention must be withdrawn from the Chinese markets within a period of six months.

In this connection, American manufacturers should appreciate the difference between the Japanese trade-mark system and the American. The right to a trade mark in the United States is based upon priority of use; in Japan it is based upon priority of registration. It is, therefore, of the utmost importance that American manufacturers who are interested in the protection of their trade marks against infringement by Japanese subjects in China, Japan and Korea should register at once their right with the Japanese Patent Bureau. Information in regard to the method of procedure, reputable Japanese patent attorneys, and the like can be obtained by direct communication with the American ambassador at Tokyo.

A Study of Four Hundred Steaming Tests

There is before us Bulletin No. 325 of the United States Geological Survey entitled "A Study of Four Hundred Steaming Tests," by Lester B. Breckenridge. The tests were made at the fuel-testing plant at St. Louis, Mo., in 1904, 1905 and 1906.

When it is realized that this report, which covers some 180 pages and is illustrated by 75 cuts, is a digest of an enormous amount of material that was far too bulky to publish in its entirety, the futility of attempting to review it in the space of a few paragraphs is obvious. Yet there are some conclusions which are so much at variance with accepted ideas, and others which, if they are truly prophetic, point to such a revolution in boiler and furnace design, that they may well be mentioned even if in a somewhat disjoined manner. All of these tests were made under a Heine boiler fitted with a hand-fired furnace, the principal object being to determine the relative value of coals for steaming purposes. All tests were made at about the rated capacity of the boiler and at a steam pressure of about 80 pounds. The basis used for the calculation was the "72*, efficiency of boiler, per cent." in the code of the American Society of Mechanical Engineers.

An interesting investigation was made of the effect upon efficiency of a large increase in furnace temperatures. We quote "The most interesting showing is that the code boiler efficiency (72*) rises only 2 per cent. as the combustion chamber temperature rises from 1800 degrees to 2700 degrees Fahrenheit. This showing is in accordance with other charts and with the theory of boilers deduced later, all being to the effect that a rise of about 1000 degrees Fahrenheit in furnace temperatures improves the efficiency of the boiler as a heat absorber only about 10 per cent. Most of this gain, however, is offset by incompleteness of combustion chargeable to the restricted oxygen supply required to get the high temperature." We are certain that this condition is directly opposed to generally accepted opinions, in fact the original view taken by the investigators at St. Louis agrees with this supposition for we read, "It seems almost axiomatic that the higher the initial temperature, the greater the amount of heat which will pass into the boilers, because of the greater temperature difference between gases and water. Yet this proposition is only slightly true. Likewise it seems axiomatic that a high combustion temperature will certainly aid combustion of smoke and hydrocarbons which it would do if other accompanying conditions were not usually adverse enough to neutralize all gain."

An optical pyrometer was used throughout the tests to determine the temperature of the combustion chamber at various points. The results of the observations with this instrument differed so widely from the temperatures calculated from the code boiler efficiency (72*) that an extensive investigation was gone into to discover the causes of the variations. These investigations lead to a study of the work of Perry on the transmission of heat. According to Perry's theory the rate of heat impartation to a boiler tube is, for ordinary gases, proportional to (1) temperature differences of the gases and of metallic surfaces; (2) density of the gases; (3) velocity of the gas parallel to the metallic surface and (4) specific heat of the gases at constant pressure." The first of these factors is the one which is usually thought of, as its applicability is perhaps self-evident. This theory of Perry's was to a certain extent verified by study of a large number of tests. We quote "Later on the work of Perry on the boiler as a heat absorber was developed and it was realized that the facts at the testing plant agreed somewhat with the theory and pointed in the right direction. In this connection it must be remembered that a lower flue temperature does not always indicate a lower B.t.u. loss, but generally a larger one because the mass of gases is more than enough larger to make up for the difference, but in any one boiler the net difference is usually within 5 to 15 per cent."

In regard to constituents of coals which cause clinkering, we find several partially contradictory statements, but these variant statements are recognized in the text. We quote, "It must be remembered that the fineness of subdivision and the distribution of the minerals throughout the coal are probably as important as the temperature and chemical composition, thus it is that sulphur in the form of little balls is nearly harmless; in the form of veins or layers it is liable to cause trouble, but in the form of 'black sulphur' so finely distributed as to be invisible, it is most troublesome * * * The coals giving high efficiencies are apt to form a very slightly smaller percentage of clinker and the high efficiency tests are likely to be made on coals low in sulphur, distillation being rather marked. However, it must be remembered that high sulphur coals are usually high in ash also." Referring to a certain chart we find this statement, "Curve No. 4 indicates that high percentage of clinker accompanies high sulphur content, but it must be borne in mind that perhaps sulphur itself has little to do with fusability of ash and that the iron which is combined with a part of the sulphur is only one of the factors in clinkering * * * The impression is general that iron causes clinkering. The tabulation partially confirms the impression as the percentage of iron in dry coal increases in general with the clinker. Nevertheless, iron is only one cause of clinkers and its presence in considerable quantity does not necessarily mean that a coal will clinker * * * To make a general statement, it may be loosely said that the tendency of a coal to clinker varies directly with the sulphur (iron pyrites) and inversely with the ash in the coal."

One section of this report is entitled, "Commercial Considerations," and is divided into four paragraphs. The prediction made in the first two are startling and if fulfilled will make present practice look shamefully wasteful. We quote these four paragraphs entire.

"*General.* Inasmuch as the boiler plant is at present the expensive portion of a steaming outfit, and as it probably is possible to cut its cost down to a fraction of the present cost and at the same time obtain a higher efficiency, it is felt that there is good ground for anticipating an enormous improvement in the production of steam power within the next few years. If so, it will not be the first time that a new arrival in a field has spurred on older forms of enterprise to a higher prosperity than they ever dreamed of before. The competition of the gas engine may be the best thing that ever happened to steam engines and turbines. The statements, theories and proposals made in this study are widely scattered and may not have been plain because they are mathematically involved. For this reason a short summary will be made here of the possibility of so improving the system of working steam-turbine plants that they may be permanently kept above commercial competition from gas-producer and gas-engine plants in large powers. Of course there is little doubt that a great field awaits the gas engine in smaller plants, say, under 5000 horse-power. All these suggestions are tentative only.

"*Boilers.* The authors see no reason why boilers cannot be constructed and properly operated with entire satisfaction which will produce about ten times the amount of steam now obtained per square foot of heating surface and with no difficulty in maintaining dry steam. The efficiency from coal to steam should easily be made considerably higher than that of a good performance of today. Such a plant would require only a fraction of the present investment in steam-plant building and real estate. Perry states in his book, 'The Steam Engine, Gas and Oil Engine,' that he thinks boilers should be made to do ten and possibly twenty times the work they do at present.

"*Furnaces.* It will probably be found on attempting this reduction of dimensions and cost that the limit will be not in the boiler as such, but in the combustion chamber. Burning a large amount of coal on a small grate area is largely a question of draft and continual riddance of ash, but the rate of travel of gases through a combustion chamber is dependent practically only on the amount of carbon burned in a unit of time, the rate being about the same no matter what the air supply per pound of carbon. As combustion chambers are now constructed for Western coals they are too small, but small is a word not to be understood in this connection as referring to volume or length alone. By a small combustion chamber is meant a chamber in which either the time spent by the gas in traveling from the front to the rear of the boiler is short or the mixing devices are inefficient or absent. In the discussion of mass action, it was stated that mere length of combustion chamber counts for little—that mixing is what counts—and thus there is a possibility of enormously increasing the efficiency of a combustion chamber as a burner of volatile matter. Effort in completing a steam-generating outfit of small dimensions must be largely concerned with the construction of a combustion chamber containing many gas-mixing appliances.

"*Turbines.* The work on turbines is provisional only, but it is believed that all the assumptions made are on the side of safety, that is, that the overall efficiency of the turbines working with high superheat and low pressure will probably be greater than estimated."

New Publications

CURVES FOR CALCULATING BEAMS, CHANNELS, AND REACTIONS. By Sidney Diamant. 13 10x7-inch pages of text and tables, and 25 graphical charts, not indexed. McGraw Publishing Company, New York City. Price, $2, net.

This work consists of a most useful set of curves or graphical charts for determining steel floor beams having a uniformly distributed imposed load, together with explanatory text and tables of the properties of standard beams and channels. Graphical charts, Plates 1 to 13 inclusive, determine the size of channels or beams for a given load in pounds per square foot, a given length of span in feet and a given width of supported area in feet. Each chart is plotted for a given load in pounds per square foot, ranging from 80 pounds in the case of Plate 1, to 500 pounds in the case of Plate 13. The charts of Plates 14 to 25, inclusive, determine reactions for a given load in pounds per square foot, a given span in feet and a given width of supported area in feet. As before, each chart is plotted for a given load per square foot, ranging from 8c pounds in the case of Plate 14 to 400 pounds in the case of Plate 25. The charts are well worked out and will commend themselves to the engineer and designer; for they provide means for eliminating tedious and uninteresting computations, and for simplifying and hastening estimating and checking.

New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make It Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

Tilting Crucible Furnace

A new tilting crucible furnace has just been put on the market which embodies several features that will be of interest to all foundrymen. As can be seen from the sectional views, the crucible is not removed while pouring the metal from the furnace, but remains fixed and the metal is transferred to the molds by means of a heated ladle or crucible, as preferred.

The burner uses either oil or gas fuel, and is operated with a fan blast of only 12 ounces, which makes a quiet burner. This is located at the top of the heating chamber, and the flame is projected down against the bottom of chamber instead of against the crucible. This increases the life of a crucible and in case it breaks, the metal is all retained in the furnace instead of running out on the floor, and the melting may be continued until the metal is at the proper temperature, when it may be transferred to the molds in the usual way. This feature allows crucibles to be used until they wear out, instead of making it necessary to throw them away before they actually break, as is often done, thus losing several heats from them.

Any air pressure from 12 ounces to 2 pounds may be used, so that the furnace can be operated from any available air and oil system which may be supplying other furnaces, a separate plant being unnecessary.

The cover is manipulated by a lever conveniently located at the rear of the furnace, from which a pin engages a quadrant and holds the door rigidly in any required position and permits covering the crucible after pouring without returning the furnace to any upright position.

Heavy pieces of metal may be fed to the crucible through the opening in the cover of the furnace while the blast is on, the waste heat passing through melts it down into the crucible very rapidly. As the crucible is not removed, after the first heat metal is always charged in a hot pot, which greatly facilitates the melting. When it is advisable that the heated gases in the furnace should not come in contact with the metal, a cover may be put on the crucible to protect it during the melt. This is unnecessary for ordinary work, as scrap yellow brass stampings from the ends of safety pins have been melted hot enough for pouring very light castings with a loss of but 3 per cent., the only precaution taken while melting was to cover the metal with a few pieces of hard coal.

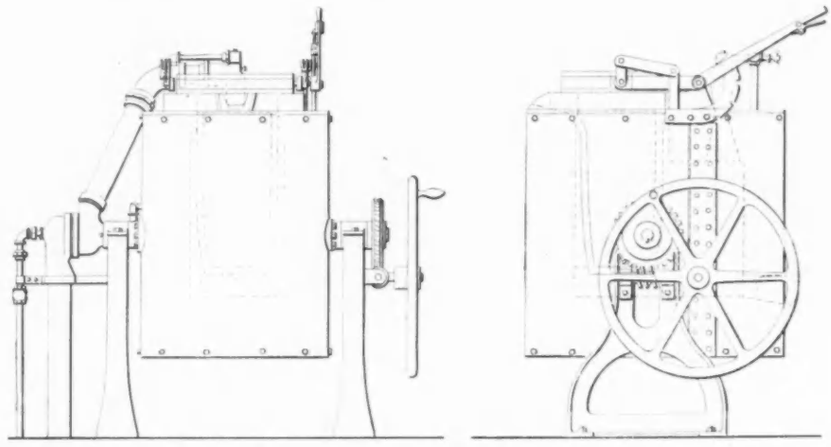


FIG. 3. SOME OF THE DETAILS OF CONSTRUCTION

The number of heats per day varies from 3 to 10, and the amount of fuel required ranges from 1½ to 3 gallons of oil, 210 to 420 cubic feet natural gas, 315 to 630 cubic feet illuminating gas, or 675 to 1350 cubic feet, 300 B.t.u. water gas, according to the quantity and quality of metal melted, the heat at which the metal is required, and the attention and promptness with which it is melted and poured. The furnace is easily relined with simple

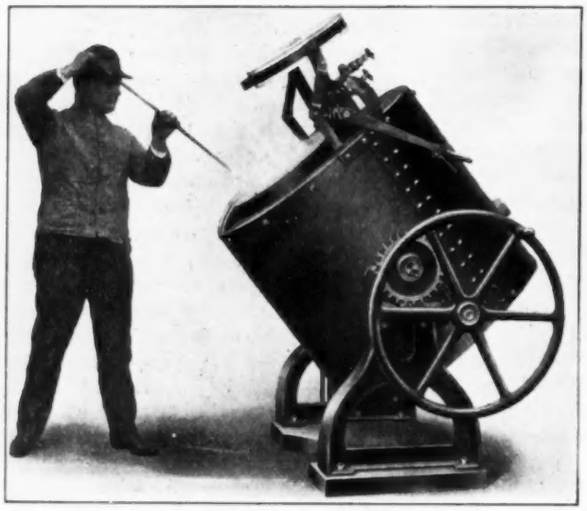


FIG. 1. FURNACE TILTED WITH COVER OPEN

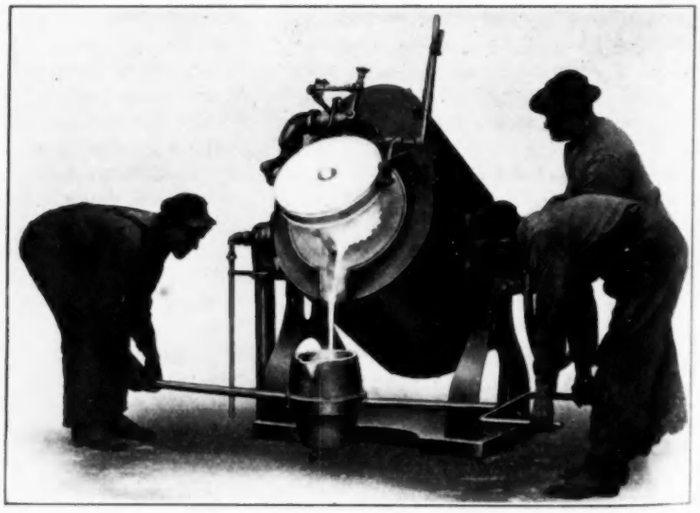


FIG. 2. POURING FROM THE FURNACE

and inexpensive fire tile. The furnaces are at present made in four sizes to hold numbers 70, 125, 275 and 450 crucibles respectively. They are made by the Rockwell Furnace Company, 26 Cortlandt street, New York.

Self-centering Arbor

The illustrations almost tell the story of the way in which this arbor is adjusted to various sizes and how the three-point bearing at each end centers even a rough hole and holds the work for turning or facing. Fig. 1 shows the construction of

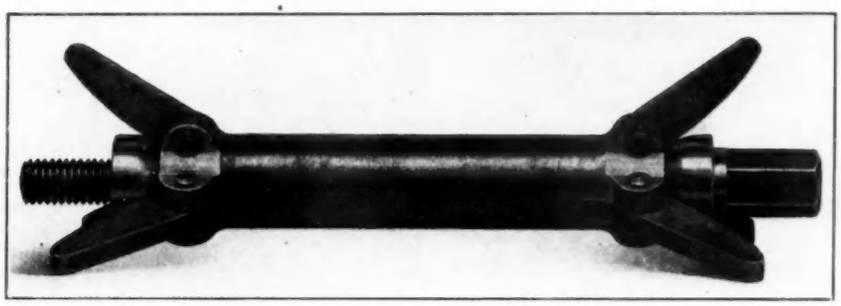


FIG. 1. SELF-CENTERING ARBOR READY FOR USE

the arbor with its three gripping points at each end, the central bolt running through the sleeve, the spherical washer and nut, which force the gripping points out or allow them to recede, and the pin in the nut which keeps it from turning so that no attention need be paid to anything but the head of the bolt.

The gripping pieces, the washer, the nut and the ends of the arbor are hardened to prevent wear and maintain the alinement

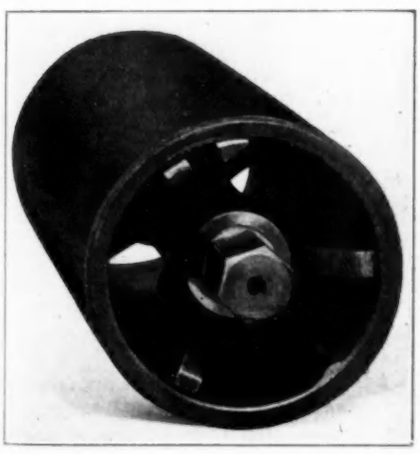
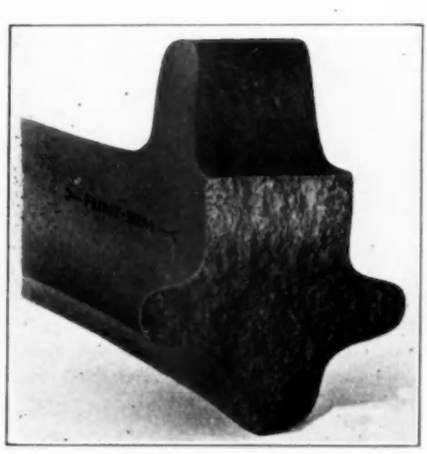


FIG. 2. THE ARBOR IN A PIECE OF PIPE

of the centers. Fig. 2 shows a pipe on the arbor ready for turning or facing, and castings can be handled in the same way. The inventor, Joseph Demarki, 194 Griffith street, Jersey City, N. J., has applied for patents on the device. They are designed to be made in two sizes, one to hold from 4 to 10 inches, the other from 10 to 20 inches, but if intermediate sizes are deemed desirable, they can be easily made.

Special Sprocket Wheels

This sprocket wheel, illustrated by the sectional view, has been developed to meet the requirements imposed by the handling of abrasive materials, and by working conditions too severe for the employment of the regular cast-iron wheel. The teeth and rim exposed to the wearing action of chain contact are hardened to a considerable depth, and the surface made smooth and uniform.



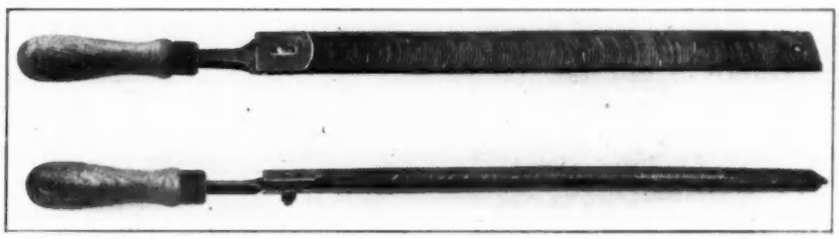
A SPECIAL SPROCKET RIM

This improvement in sprocket wheels not only makes the wheel more durable, but also prolongs the life of the chain by maintaining the original accuracy of fit between the links and the sprocket teeth. The makers, Link-Belt Company, Philadelphia, Chicago, and Indianapolis, have coined and copyrighted a trade-name "Flint-Rim" for the new wheels, which are now ready in most of the active sizes of the "Ewart" type of chains.

Something New in the File Field

Files have been made in the same way for so many years with the long angular tooth of the single cut or the hundreds of small teeth of the double cut that we had almost come to believe it would never change. Necessity was again the mother of invention, however, and Alexis Vernaz, a Swiss machinist, being up against a proposition of filing material that none of the files in the shop would any more than touch without losing their teeth and usefulness, began experimenting with various cuts, milled or planed into the strip of steel used for the file body. Angular and herringbone teeth finally evolved into the circular cut shown in the illustration and this not only handled his particular job but seems to be adopted for almost everything that needs filing.

One peculiarity is that one cut, 9 teeth to the inch, seems to fit almost any kind of work and leaves a surface as smooth as



A FILE WITH A NEW KIND OF TEETH

the grade of file known as "smooth" in the file trade. They are also making a file with 12 teeth to the inch for those who are a little afraid of the other. This is because the cut is really a shear or planing action, while in the other it means that the cutting points come nearer to making a continuous cut. Soft wood, hard wood, babbitt, aluminum, marble, cast iron, brass and steel, seem all one to this file, much as it would to a planing tool or milling cutter. The cutting edge is well supported, the clearance ample and the curve allows the chips, for real chips are cut when filing with any strength, to roll out of the way and there is no clogging with its consequent scoring of the work.

The large files, 8 to 18 inches, are made to be used with backs as shown, while smaller files will later be made with the forged tang as usual. The back allows heavy pressure to be put on the file without bending or breaking (although they advise a slighter pressure than usual and a slow stroke), even when they have been recut several times, as can be done. They also have a machine for regrinding the

files on the top of the tooth, the depth of the throat being sufficient to allow this without detriment. The holders are very simple affairs and allow the files to be reversed at will. A holder and handle goes with each dozen files.

The teeth are accurately milled by a hollow mill on special machines, which automatically advance the cutter into the work, withdraw it and space the blank in much the same manner as a rack cutter.

While no exhaustive tests of this file have been made in this country, the European makers claim that they cut from two to three times as fast as the regular file and that the life is very much longer, owing to the fact that it is in reality a hand-planing tool rather than a file in the ordinary sense. The material is the best crucible steel and is imported especially for this purpose, making a tool that should and does cut in much the same manner as a milling cutter or multiple planing tool. For the present it will be made in only the flats but the half rounds will come a little later.

The files have been made and used in France for about two years, for something over a year in England, and are just being put on the American market by the National File & Tool Company, The Bourse, Philadelphia, who have named it the "Vixen."

Cutting Oil Grooves

By Edward Hurst

Some time ago an order came in for 60 steel thrust collars. These collars were to be made of mild-steel plate, ¼ inch thick, turned to 10 inches and bored to suit a 5-inch shaft, with an oil groove ⅛ inch deep by ¼ inch wide, cut in both sides. Since this order involved the cutting of 120 grooves, some device for saving time was naturally thought of. A pneumatic hammer and a round-nose tool were proposed by a husky machinist for making time. When supplied with the hammer and chisel he then wanted a special device for holding the collars. The manufacture of this holding device led to the work being done in a 22-inch engine lathe.

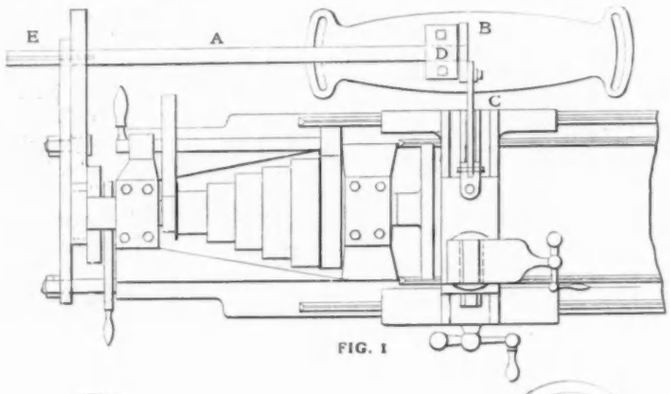


FIG. 1

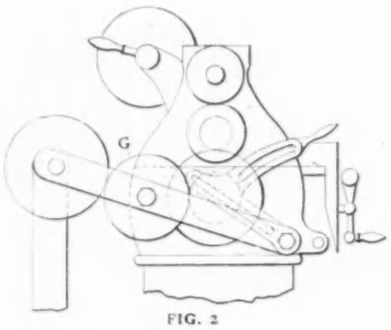


FIG. 2

FIG. 6

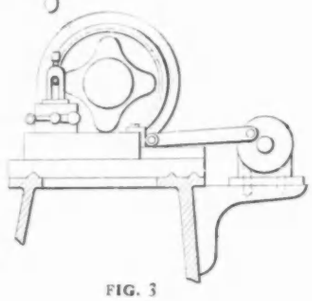


FIG. 3

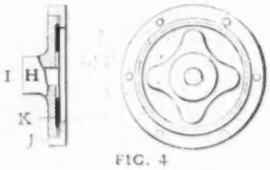


FIG. 4

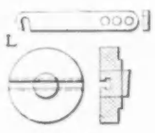


FIG. 5

FIG. 7

LATHE ATTACHMENT FOR CUTTING OIL GROOVES

In Figs. 1, 2 and 3 are shown plan, end view and cross-section of the lathe; the latter view also showing the shape of the oil groove to be cut. It will be seen that the device consists of a shaft *A* driven at one end by the gearing ordinarily used for screw-cutting, while at the other end is attached a crank disk *B*, which by means of the connecting-rod *C* imparts a reciprocating motion to the cross-slide. The bearing *D* is located on the support ordinarily used for the taper attachment, this being removed in this case. The bearing *E* is supplied by an iron support, as shown in Fig. 3. The gearing shown is a combination which gives a ratio of 4 to 1, the spindle making one revolution while the crank-shaft makes four. The gears used were 96 and 48 on one stud, and 72 and 36 on the other. Gear *G* is merely an intermediate. Thus, as will be seen, through the medium of the gears, shaft, crank and connecting-rod, the screw slide makes eight reciprocations while the chuck makes one revolution.

The washers or collars are securely held in the chuck, shown in Fig. 4. The casting *H* is threaded at *I* to suit the lathe spindle, and at *J* to suit the clamping ring. A shallow counterbore to suit the collars is shown at *K*, and this quickly brings the work central. When the collar is put into the counterbored seat, the clamping ring is screwed on and set up tight by means of a spanner wrench fitting into the holes shown. This chuck securely holds and accurately centers the work, and at the same time leaves exposed sufficient area for the oil grooves.

The cross-feed nut being removed the tool is necessarily fed by the compound rest. The cutting tool for steel requires only the customary top-rake, but an abnormal amount of front and side clearance. The clearance necessary is dependent upon the throw of the crank and the number of reciprocations per revolution of spindle.

The throw of the crank is made variable by means of the adjustable crank disk, Fig. 5. The adjustment is accomplished by the utilization of a crank-pin with a head sliding in the T-slot shown. The variation in the length of the connecting-rod was cheaply realized by drilling in it a series of holes. These holes with the addition of the tool-post movement, give all the lateral adjustment necessary for enabling large or small work to be done. The slot *L*, shown at one end of the connecting-rod is used for quickly detaching the lathe carriage, thus enabling work to be put in or taken out of the chuck with ease, the carriage being run back.

The shape of the groove can easily be altered by changing the gearing, the throw of the crank, or the form of the cutting tool. The position of the groove can be varied by changing either the tool-post position, or the length of the connecting-rod.

Fig. 6 shows the form of groove obtained by gearing with a ratio of 3 to 1. In Fig. 7 the effect with 6 to 1 gearing is shown; this application being on horseshoe thrust collars for marine-engine thrust bearings. These collars are babbitted, and the device will be found to make excellent time in this soft metal, giving a nice even curve, without any liability of displacing the babbitt, and successfully exposing all the area to lubrication.

An Interesting Trip Across the East River

EDITORIAL CORRESPONDENCE

It is the daily practice of some 550,000 people to cross the East river by bridge, but to make the trip on a foot-path 12 feet wide, inclined from one tower about 320 feet high to the center of the span

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novel experience; that is, novel to the ordinary mortal. But from the manner in which the men "on the job" of building the foot-paths of the new Manhattan bridge conduct themselves, one would imagine that the possibility of a drop of about 250 feet is a mere incident.

On the occasion of a trip of this kind shortly after the foot-paths, of which there are four, were completed, it was interesting to note the indifference with which the workers treated their precarious positions. One example will suffice to show the reader the apparent recklessness with which these fellows carry themselves—and it is explained that it is this very unmindfulness of the danger that prevents accidents; for as one of them remarked, "it would never do to be scared of anything on these kinds of jobs." To get back to our example, a guide named Henderson was piloting a party over one of the paths when he decided there was something on the adjoining path that required his attention and he immediately proceeded to walk across the intervening space of about 20 feet on a connecting beam six inches broad, some 170 feet above water.

Another interesting incident of the trip was what might be termed an example of "high art." A practicing attorney of New York City was in the act of descending from the top of the tower toward the center and was in a most picturesque pose when Cooper, a well known artist of New York and Paris, seized the opportunity, requested a halt, and got busy with his pen and pad. Another of the "sky-larks" leaning on the handle of his hammer, on a ledge 6 inches wide, an interested onlooker, suggested the caption "Law and Art on the Decline."

The actual stringing of the four main cables was started August 10 and under ordinary conditions this work will be completed in from six to eight months' time. Each one of these cables contains 9472 wires of 0.19 inch diameter so that the four cables will contain sufficient length of wire to nearly circle the globe. Unwrapped and clear of outside protection the cables measure 21½ inches in diameter and will be subject to a maximum load of 73,000 pounds to the square inch.

The structural ironwork of the bridge is practically all complete and stored at Bayonne, N. J. As soon as the cables are strung this material will be transported and it is estimated that the bridge will be completed in the latter part of 1909.

Business Items

The Goldschmidt Thermit Company are erecting a new machine shop and foundry which will be equipped in an up-to-date manner for special attention to the rapid execution of repairs to electric motor cases, truck frames, gear wheels, crank-shafts, etc., etc.

The work on the new Ford factory at Highland Park, Detroit, Mich., has been started and the contract calls for completion of the plant by January 1. The main building of the new factory will be the largest building under one roof in the state of Michigan and the largest automobile factory in the world.

Trade Catalogs

The R. K. LeBlond Machine Tool Company, Cincinnati, Ohio. Catalog describing cutter and tool grinder., Illustrated, 64 pages, 6x9 inches, paper.

National File and Tool Company, The Bourse, Philadelphia, Penn. Catalog describing Vixen patent milling file. Illustrated, 16 pages, 4x7½ inches, paper.

Hardinge Bros., 1034-40 Lincoln Avenue, Chicago, Ill. Booklet No. 3, describing Beyer watchman's portable time detectors. Illustrated, 20 pages, 3½x6 inches, paper.

Rockford Drilling Machine Company, Rockford, Ill. Catalog of drills, tool grinders, horizontal drilling, boring and tapping machine etc. Illustrated, 64 pages, 6x9 inches, paper.

The United States Electrical Tool Company, Cincinnati, Ohio. Catalog describing portable electric tools, including drills and grinders. Illustrated, 52 pages, 6x9 inches, paper.

Weber Gas Engine Company, Kansas City, Mo. Brochure No. 60 describing Weber "Down-Draft" suction gas producer for bituminous fuels. Illustrated, 4 pages, 4x9 inches, paper.

Jos. Dixon Crucible Company, Jersey City, N. J. Booklet describing graphite brushes with hints concerning the testing of brush pressure and filing of mica insulation, etc. Illustrated, 12 pages.

International Electric and Engineering Company, 148 Chambers street. Catalog "S.&N" heavy duty beam shears, coping machines, bar and angle cutters. Illustrated, 12 pages, 9x12 inches, paper.

Business Opportunities

The Wheeling City Water Works are considering plans for a new pump.

A new plant is to be erected at Springfield, Ohio, by the Victor Rubber Company.

A new plant of the American Iron and Steel Company, Albany, N. J., is to be built at Harrisburg, Penn.

The Wilbraham-Green Blower Company, Kensington, Penn., are soon to erect a new plant at Pottstown, Penn.

A factory for the manufacture of launches is to be erected at Manston, Wis., by Victor Patterson and Karl Sharp.

Work on two additional buildings for the Standard Cast Iron Pipe and Foundry Company, at Bristol, Penn., has been started.

Everett Green, proprietor of metal working establishment in New Bedford, Mass., intends to erect a new building with larger accommodations.

The Velie Motor Vehicle Company, Moline, Ill., a new concern with a capital stock of $150,000 has started the erection of a three-story factory building.

The Tennessee Coal, Iron and Railway Company will shortly begin the erection of two furnaces at Ensley, Ala., chiefly for the handling of scrap.

The city of Pulaski, Va., voted $75,000 bonds to establish electric light and water systems. Edgar C. Wiley, Lynchburg, Va., is engineer in charge.

An addition to the Wilcomb Machine Company, at Norristown, Penn., is to be erected and equipped with a considerable quantity of new tools.

Construction of a new plant for Kibiler Bros., Corliss, Wis., is now under way in that city, for the purpose of manufacturing gas and gasolene engines.

The Smith & Winchester Company, South Windham, Conn., builders of paper machinery, will erect an addition to its plant at a cost of over $35,000.

The Prier Brass Manufacturing Company, Kansas City, Mo., will erect some new buildings. The company manufactures plumbing and railroad supplies.

The Lexington & Interurban Railway Company will erect a car barn at Lexington, Ky., with paint and carpenter shops, blacksmith and machine shops.

John Howett, of Sterling, Ill., is at the head of a company which will establish a plant at Sharon, Penn., for the manufacture of hinges, locks and novelties.

It is reported the Southern Railway Company will build roundhouse and machine shop at Strasburg, Va. D. W. Lum, Washington, D. C., chief engineer.

The Titusville Iron Works, Oil City, Penn., has commenced work on a large addition to its plant, which will comprise a machine-shop, boiler shop and foundry.

The Jackson, Church and Wilcox Company, of Saginaw, Mich., are soon to build a large addition to their plant for the manufacture of iron and steel products.

Bids will be opened by the Isthmian Canal Commission, Washington, D. C., on August 31, 1908, for supplies under Circular No. 460, among which there are the following items: Motors, traveling cranes.

Proposals will be opened by the Isthmian Canal Commission, at Washington, D. C., on September 8, 1908, under Circular No. 461 for supplies, among which appears the following items: Soft steel billets, round and hexagonal bars of tool steel, round bars of iron, cast-steel gear and engine piston, hammer drills, jacks, padlocks, sea-coal facing, fire clay, plumbago blacking, foundry flour.

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or commission on wages of successful applicants or situations.

Miscellaneous Wants

Caliper list free. E. G. Smith Co., Columbia, Pa.

Small, accurate drill jigs and dies built to order. R. Rosner, Madison, Wis.

If you use small gears in large quantities, write Berry & Parker, Erie, Pa.

DIVISION NO. 3

Steel case hardened; modern methods. Boston Gear Works, Norfolk Downs, Mass.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST,

Castings, prints, 8-inch screw-cutting foot lathe. W. Morey, 2563 Trink St., Chicago, Ill.

High power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Special machinery accurately built. Screw machine and turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Wanted—Machinery or machine parts to build by contract. Ideas developed: drawings made. Address "A," care AMER. MACH.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Wanted—A good second-hand generator, about 225 to 250 kw. and 125 volts, one that can be coupled up to main shaft or belt driven at about 400 R.P.M.; must be in first-class condition. "E. L. S.," AMERICAN MACHINIST.

Machinery built to order and by contract; special parts made; gear cutting, automobile and pattern work, punch press and screw machine work, tools, dies, etc. Blair Tool and Machine Works, West and Morris streets, New York City.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Position as superintendent; 12 years' experience as superintendent and assistant; excellent executive ability; expert designer of tools, fixtures and special machinery; specialty light high grade interchangeable work. Box 345, AMERICAN MACHINIST.

A graduated M. E., 12 years as designer and constructing engineer on machine tools and automobiles, would like to become associated with firm where a thoroughly practical knowledge of designing and manufacturing methods would be appreciated. Would prefer a small establishment, provided conditions offer opportunities. Address Box 397, AMER. MACHINIST.

ILLINOIS

Designer on special tools, jigs and fixtures. Box 400, AMERICAN MACHINIST.

Foreman toolmaker wants position with a progressive factory. Box 398, AMER. MACH.

Designer of machine tools, 8 years' shop practice, 6 years' drafting room experience, desires change. Box 373, AMER. MACHINIST.

INDIANA

By blacksmith and tool dresser; temperate, energetic; can manage men successfully; twenty years' experience; go anywhere, best of references. Address "Tool Dresser," AM. MACH.

MASSACHUSETTS

Expert grinder, surface and universal; references furnished. Box 395, AMERICAN MACH.

Draftsman and designer; practical mechanic, technical education, wide experience. Box 394, AMERICAN MACHINIST.

Practical machinist, tool and die maker, experienced foreman and inspector, age 40, married, open for engagement. Box 365, AMERICAN MACHINIST.

Position as shop manager by practical mechanical engineer with excellent experience and references. Can buy interest in good prospect. Box 393, AMERICAN MACHINIST.

Position by an American as superintendent or assistant superintendent. Practical man with drafting-room experience. Executive ability. Reference. Box 386, AMER. MACH.

MISSOURI

Superintendent with executive ability is open to engagement. Experienced in handling department foremen and employees without friction. Have exceptional experience in designing dies, jigs and labor-saving tools that produce results. Familiar with shop systems, piece work, tempering, annealing and carbonizing. Salary $5000.00. Address Box 382, AMERICAN MACHINIST.

NEW JERSEY

Mechanical draftsman wishes position. Address Box 374, AMERICAN MACHINIST.

Designer, labor-saving devices, jigs and fixtures. Can show rapid results. Box 399, AMERICAN MACHINIST.

Mechanical engineer, 8 years designing and erecting condensers, pump engines; pipe work for power plants. Box 401, AMERICAN MACH.

Experienced, capable mechanical draftsman, age 28, technical graduate, desires change at $21.00 to start. A. Werner, 228 Clark Place, Elizabeth, N. J.

NEW YORK

First-class mechanical draftsman, Corliss or high-speed engines, wants position. Box 392, AMERICAN MACHINIST.

Wanted—Mechanical superintendency. One of the live ones, up to the minute in modern shop practice. Any location. Ready for engagement at once. Box 337, AMERICAN MACHINIST.

Experimental designer and engineer, graduate, age 31. Extensive experience fine apparatus, adding machines, typewriters, automatic machinery, developing intricate devices for manufacture. Exceptionally able. Box 396, AMER. MACHINIST.

A practical mechanic familiar with making and designing tools and up-to-date factory and foundry management, reducing costs with a minimum friction, 12 years as superintendent of factories making interchangeable machinery and sheet metal parts, wishes to correspond with parties in need of his services. Box 384, AMERICAN MACHINIST.

Superintendent or assistant, age 38, practical mechanic and successful manager of help, experienced on automatic machinery, light machine tools, sewing machines, typewriters, guns, instruments and similar mechanisms. Expert designer of special tools and appliances. Several years' foundry experience. East preferred, but would go West or South if proposition was satisfactory. Box 385, AM. MACH.

NORTH CAROLINA

Engineer, 12 years' experience shop and drafting room, in steam, gas, power and electric machine. For last three years chief draftsman. First-class designer. Desires to change. Box 381, AMERICAN MACHINIST.

OHIO

Position as superintendent, 15 years' experience on steam and gas engine work. Energetic, executive and a producer without friction. Box 389, AMERICAN MACHINIST.

Mechanic expert, 38, desires change; long experience as tool and die maker, draftsman, foreman and superintendent, designer of stampings to take place of castings, labor-saving devices for all purposes, dies, tools and jigs for economical manufacture, automatic wire and sheet-metal working machinery; has inventive and cost figuring ability. A systematizer and knows how to handle help. Best of references. Box 390, AMERICAN MACHINIST.

PENNSYLVANIA

Designer, University graduate, 7 years' experience in water turbines and pumps in United States and Europe, 29 years, wants position. Box 387, AMERICAN MACHINIST.

Experienced designer desires change to similar position or one of greater responsibility. Practical machinist and toolmaker; best of references. Box 383, AMERICAN MACHINIST.

Expert cost accountant and systematizer desires an executive connection with manufacturing concern. Up-to-date methods and satisfactory results guaranteed. Box 304, AMERICAN MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

ILLINOIS

Wanted—Man to take charge of tool department in factory located in Chicago, manufacturing fine interchangeable machinery. Expert man with energy and ability and a knowledge of the best methods desired. Box 391, AM. MACH.

INDIANA

Wanted—Several first-class tool makers on jig and fixture work for automobile parts. Call or write Nordyke & Marmon Co., Indianapolis, Ind.

MASSACHUSETTS

Machinist wanted with experience as toolmaker and foreman. Golding Mfg. Co., Franklin, Mass.

Draftsman wanted with experience at machine work. Address, stating age, experience and pay required. Golding Mfg. Co., Franklin, Mass.

NEW JERSEY

... shaft, crank and connecting-rod, the screw ... slide makes eight reciprocations ...

OHIO

Wanted—Draftsman to work on the design of metal shapers in Cincinnati. Address "Shaping Machine," care AMERICAN MACHINIST.

Wanted—First-class draftsman who understands design of modern engine lathes. State experience and salary. Address "Lathe," care AMERICAN MACHINIST.

Wanted—Mechanic who thoroughly understands the manufacture of taps and dies. Capable taking charge of department with reliable concern. Good opening. State experience and former connections. Box 388, AM. MACH.

PENNSYLVANIA

Wanted—Draftsman; technical man, thoroughly trained on typewriter or adding machine work, for position in main drafting office on new model work. Address Adder Machine Company, Wilkes-Barre, Pa.

Wanted—Draftsman, for position in shop drawing room, on jigs, dies, fixtures, etc. Must be thoroughly experienced in high class small parts manufacturing and capable of designing tools for rapid production. Address The Adder Machine Company, Wilkes-Barre, Pa.

Wanted—Two model makers. Must be thorough mechanics and have had experience on models in up-to-date typewriter or adding machine experimental or model rooms. Address The Adder Machine Co., Wilkes-Barre, Pa.

Wanted—Chief inspector for small parts manufacturing shop. Must be a thorough mechanic, having had previous experience in similar line of work on typewriters, adding machines or registers. Capable of making rigid inspections of parts and finished sections of high class machines and working to variation of .0005. Address The Adder Machine Company, Wilkes-Barre, Penna.

For Sale

U. S. patent 815345, variable speed mechanism, for sale. Address "I. K.," care AM. MACH.

For Sale—Manufacturing plant equipped with electric power, machine, boiler, blacksmith, pattern, woodworking shops. Foundry and storage, with machinery, tools and stock, or plant only. Railroad switch in yard. Shipping facilities by rail, lake or canal. Address Box 318, AMERICAN MACHINIST.

Small Tools—A very complete outfit of small tools, including calipers, micrometers, gages, drills, reamers, taps, dies, wrenches, hammers, squares, bevels, lathe tools, as well as an assortment of carpenters' and pipers' tools, suitable for a repair shop, tool room, or foreman. Will sell entire lot or divide as desired. All are of the very best quality, and in good condition, many being entirely new. Address Box 113, Southbridge, Mass.

For Sale—Tracings, patterns, jigs and templets for the following size gas and gasolene engines: 1½, 3 and 5 horse-power vertical and 3, 5, 8, 10, 12, 16 and 20 horse-power horizontal; also a number of finished and unfinished engines of the above sizes. All of the above sizes have been in successful operation for several years. This is a splendid opportunity for anyone wishing to build gas or gasolene engines. You can save thousands of dollars in experimental work by purchasing this complete outfit. Shop rights of valuable patents on these engines will be given to purchaser. Box 366, AMERICAN MACHINIST.

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